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FINANCIAL IMPACTS OF GOVERNMENT SUPPORT PRICE PROGRAMS

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FINANCIAL IMPACTS OF GOVERNMENT SUPPORT PRICE PROGRAMS

Michael Boehlje and Steven Griffin*

Introduction

Various forms of income subsidy and price support programs have been a part of government farm policy since early in the 20th Century. The most recent farm program legislation, the Agriculture and Consumer Protection Act of 1973, uses the concept of "target prices" to activate income subsidies to farmers if market prices should decline below these "target" or support levels. Current discussions concerning new farm policy programs include proposals to increase the support prices for feed grains. In addition, it has been proposed that the support prices be adjusted in future years based on USDA cost of production studies to reflect changes in the prices of production inputs. In reality, this adjustment process is a form of inflation indexing as practiced in many other sectors of the U.S. economy. Controversy has arisen in specification of the indexing process concerning the measurement of costs, particularly the annual charge for services of land, and the procedure to be used in reflecting land value increases in the index.

In essence, the support prices operate to set a floor in terms of prices and price expectations of producers. They also influence the cash flow of the farm business and thus its debt carrying and debt servicing capacity.

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The purpose of this paper is to discuss and document the impact of support price programs on investment and financing behavior of producers with different characteristics in different size categories. The working hypothesis is that indexed support prices will increase the guaranteed cash flow of the farm business and reduce the financial risk, resulting in increased bid prices for durable assets such as land, increased debt-carrying capacity and thus financial leverage, and more rapid rates of growth of the firm. Analysis of these impacts by size of firm and characteristics of the entrepreneur will also provide implications concerning the effect of support price policies on size distribution and the ownership and control of agricultural resources.

The following section will review the conceptual framework for the empirical model with emphasis on incorporating price support programs and price expectations into a firm valuation model. An empirical model will then be developed to use in investigating the working hypothesis. The results of this empirical analysis will be reviewed with a final section devoted to conclusions and implications.

The Conceptual Framework

Theory and Concepts [1/]

The conceptual and empirical models must be structured to indicate the impact of support price programs on price expectations and thus incomes and value of a firm, given specified financial characteristics and constraints. Thus, the conceptual base for the analysis comes from a combination of the theory of the firm and the theory of valuation. Specifically, the value of

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[1/] This section draws heavily from and uses the same notation as Vickers, Douglas, The Theory of the Firm: Production, Capital, and Finance, McGraw-Hill, New York, 1968.

an asset can be determined as:

1) $V = \frac{\pi}{\rho}$

where V denotes value, π is the residual income to the asset, and ρ is the capitalization rate. This basic capitalization formula can be used to determine both the value of an asset and the value of the ownership or equity investment in a firm.

For the firm, the residual income can be defined as:

2) $\pi = p(Q)\ f(X_1, X_2) - \gamma_1 X_1 - \gamma_2 X_2 - r(D) \cdot D$

where p(Q) is the selling price of the product, X_1 and X_2 are real factors of production with $f(X_1, X_2)$ denoting the output forthcoming, γ_1 and γ_2 are unit factor costs, r(D) is the interest rate on debt, and D denotes the amount of debt used in the firm. Thus, income is a function of the amount of debt and real factors of production used, the production function, the prices of debt and real inputs and the product price. The support price mechanism enters the profit function 2) through the price function - p(Q) - for the product.

Assuming utility is a positive function of income and a negative function of risk (both operating and financial risk), the capitalization rate could be specified in general as:

3) $\rho = a - b(K+D) + c(\frac{D}{K})^2$

where K represents the equity capital employed in the firm, D represents the debt capital and a, b and c denote parameters of the utility function. Equation 3) indicates that the capitalization rate is a decreasing function of firm size -- (K+D); and an increasing function of the square of financial leverage -- $(\frac{D}{K})^2$.

Finally, the financial characteristics and constraints faced by the firm can be represented by a money capital constraint of the form:

4) $g(Q) + \alpha X_1 + \beta X_2 \leq K + D$

where $g(Q)$ represents working capital, α and β represent the financial requirements for each input and the other variables are as defined earlier. Equation 4) implies that the financial requirements to support production cannot exceed the sum of the debt and equity funds of the firm.

The decision variables of the model include X_1 and X_2 - the optimal quantities of the real inputs to use, and D - the optimal quantity of debt to include in the financial structure of the firm. By specifying a Lagrangian function to reflect constrained optimization and taking the first partials with respect to X_1 and X_2, first order optimizing conditions of the form:

$$5) \quad \frac{dX_2}{dX_1} = \frac{\gamma_1/\rho+\mu\alpha}{\gamma_2/\rho+\mu\beta}$$

are obtained. All parameters in 5) are defined as earlier except μ which is the Lagrange multiplier and can be interpreted as the marginal value product of money capital. According to Vickers (1968, p. 164), "the numerator of the right-hand-side (of equation 5) represents the capitalized value of the direct factor cost γ_1/ρ, plus the marginal value productivity of money capital times the factor's money capital requirement (financial requirement) coefficient $\mu\,\alpha$. This last term is the valuation of the capital cost to be imputed to the factor of production, . . ."

Taking the partial derivative of the Lagrangian function with respect to the final decision variable, D, and rearranging results in:

$$6) \quad \mu = \frac{1}{\rho}\left(r+D\frac{\partial r}{\partial D}\right) + \frac{\pi}{\rho^2}\frac{\partial\rho}{\partial D}$$

All of the variables have been defined previously. The first argument on the right-hand-side of Equation 6) is the capitalized value of the marginal interest cost (the term in parenthesis is the increase in total interest payments that results from using increased amounts of debt). But by Equation 3), the capitalization rate is also a function of the amount of debt used, so the second argument of Equation 6) represents the increase in the equity capitalization rate with increased debt use which results in a depressing effect on capitalized income. So at the optimal level of debt utilization, the marginal value product of money capital must exceed the capitalized value of the marginal interest cost by the marginal response in the capitalization rate to increases in debt utilization.

<u>The Model</u>

The specific model used for the empirical work parallels the conceptual framework developed earlier and has the following structure:

7) $V_t = \dfrac{E(R_t)}{k_t}$

8) $E(R_t) = [\ E(P_t) - C_t\ ] \cdot Q_t - \eta\ D_t$

$C_o = TVC + XMC + OVH + XLC$

$C_t = (1 + \Theta_1)\ C_{t-1}$

9) $Q_t = \phi A_t$

10) $A_t = O_t + D_t$

11) $SL_t = G(\P, C_t)$

12) $E(P_t) = \int_{SL_t}^{\infty} N(p, P^*_t, \sigma^2_{p^*_t}) \cdot p\ dp + \int_o^{SL_t} N(p, P^*_t, \sigma^2_{P^*_t}) \cdot dp \cdot SL$

$P^*_t = P^*_o \cdot (1 + \theta_2)^t$

$\sigma^2_{p^*_t} = \pi \cdot P^*_t$

13) $k_t = CAP\ (CC, MTR, \eta, DP, GNI, GLV)$

14) $CC = \omega + \delta\ \sigma_{R_t}^{\ 2}$

15) $\sigma_{R_t}^{\ 2} = Q^2_t\ V(P_t)$

16) $V(P_t) = \int_{SL_t}^{\infty} N(p, P^*_t, \sigma^2_{p^*_t}) \cdot p^2 \cdot dp + [\int_o^{SL_t} N(p, P^*_t, \sigma^2_{P^*_t})\ dp \cdot SL^2] - E($

17) $D_t \leq \{^{\Delta}_{\xi}\ ^{O_t}_{E^t}\ (R_t)$

Equation 7) is the basic valuation formula and indicates that the

value of an asset or the firm V_t is equal to the expected income stre...

capitalized by the appropriate rate k_t. The expected income stream is defined in Equation 8) as the expected price $E(P_t)$ minus production costs C_t times the output Q_t minus interest on debt $\eta\ D_t$. Production costs are composed of variable costs TVC, machinery costs XMC, overhead OVH and land charges XLC and are assumed to increase at a specified rate θ_1 over time. The production function of Equation 9) specifies output as a function of assets A_t. The financial structure of the firm is defined in Equation 10) as assets A_t equal to equity O_t plus debt D_t.

The government price program enters explicitly in the specification of price expectations as indicated by Equations 11) and 12). A dynamic support price adjustment mechanism is specified in Equation 11) where the support level (SL_t) is a function of the policy variable of the proportion and type of costs to include ¶ and the cost of production per unit of output C_t. This support level influences the price distribution and expectation model as summarized in Equation 12).[2/] The price distribution is comprised of two components, the proportion above the dynamically adjusted support price (the first argument of Equation 12)), and the proportion that is truncated because it is below the support price (the second argument of Equation 12)). In essence, the truncated area is redistributed over the remaining portion of the distribution, thus affecting both the mean and variance of the price expectations distribution. Although numerous techniques of redistribution are possible, the current procedure calls for "stacking" the truncated area on the distribution at the support level. The original expected product price is also assumed to be inflating at a rate of $(1 + \theta_2)$ per year.

The capitalization rate k_t is specified in Equation 13) as a function of the opportunity cost of capital CC, the marginal tax rate MTR, the interest rate η,

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[2/] The price distribution described in Equation 12) represents a normal distribution with first and second moments defined by P_t^* and σ^2_{p*} respectively. However, any probability distribution could be used in the model.

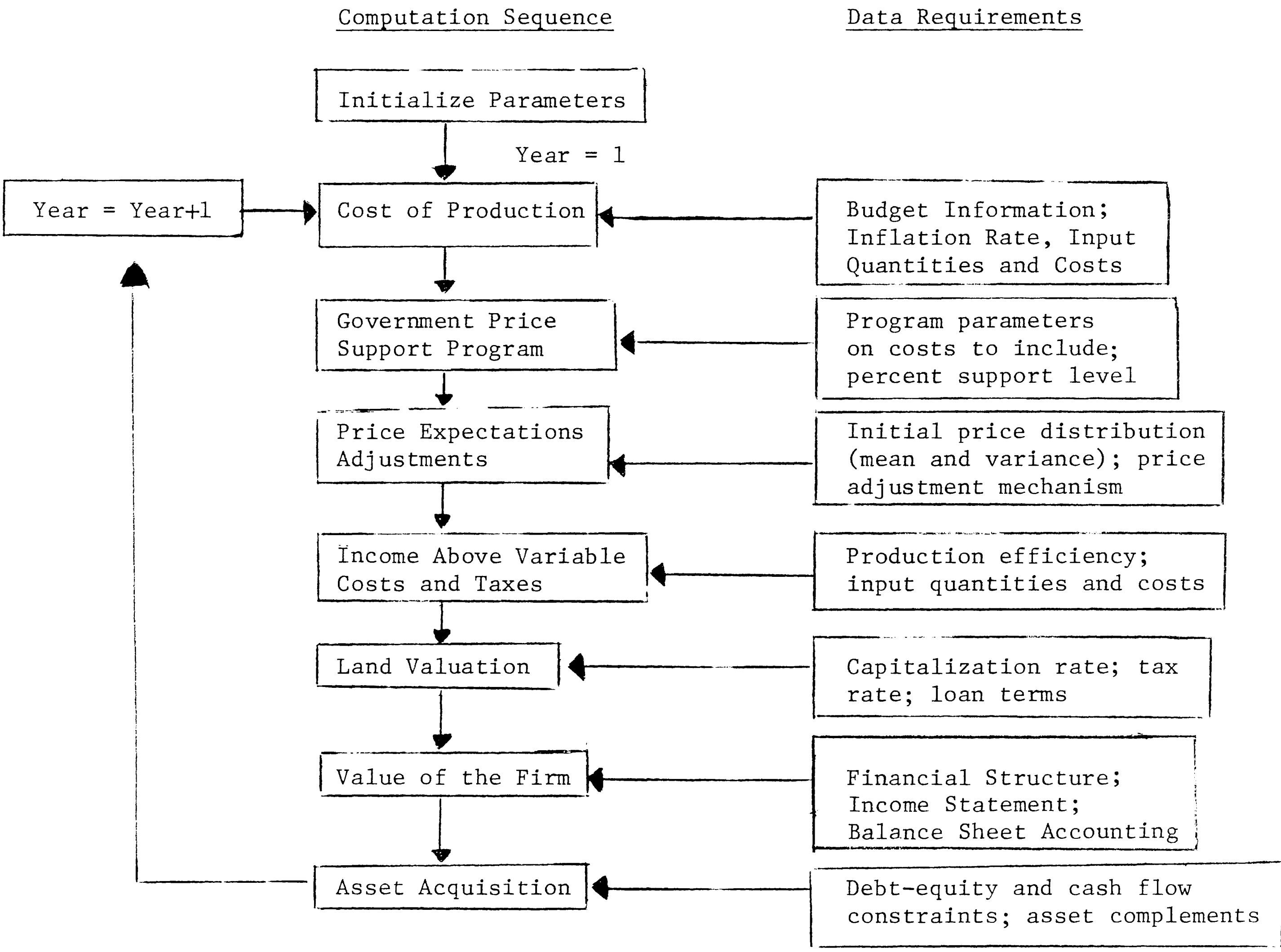
the downpayment on the real estate loan expected DP, the growth in net income GNI, and the expected growth in land values GLV. The specific functional form of this relationship developed by Lee and Rask (p.986) was used in the numerical model. Equation 14) indicates that the opportunity cost of capital is a function of the variance in return $\sigma^2_{R_t}$, where the variance in return is specified in Equation 15) as the variance of price $V(P_t)$ times the square of output Q^2. The variance of price is defined in Equation 16) as the second moment of the modified price expectations distribution. Finally, the utilization of debt is constrained by Equation 17) to a proportion of the equity capital O_t (debt to asset ratio), or a proportion of the expected income of the firm $E(R_t)$ (cash flow for debt servicing).

The parameters of the model include the interest rate (η), the production response parameter (ϕ), the price expectations and support price parameters (P^*_o, ¶, π, SL_o), the expected rates of inflation (θ_1 and θ_2), the parameters of the opportunity cost of capital as obtained from the utility function (ω and δ), and the financial constraint parameters (Δ and ξ). The impact of various values for these parameters will be demonstrated in the empirical results. Also, for empirical application, a set of initial conditions or values must be specified for A_t, O_t, D_t, C_o, MTR, DP, GNI, GLV. Different values for these initial conditions will simulate the behavior of different entrepreneurs with different farm sizes and financial structures.

The Numerical Model

A computer simulation model was constructed to parallel the conceptual model of Equations 7) - 17) and generate numerical results for Midwest corn farmers. In essence, the model includes two assets--land and all other productive assets (machinery, crop inventories, cash)--and one commodity--corn. The flow chart of Figure 1 summarizes the structure and data requirements of the simulation model. The first step of the analysis is to initialize various

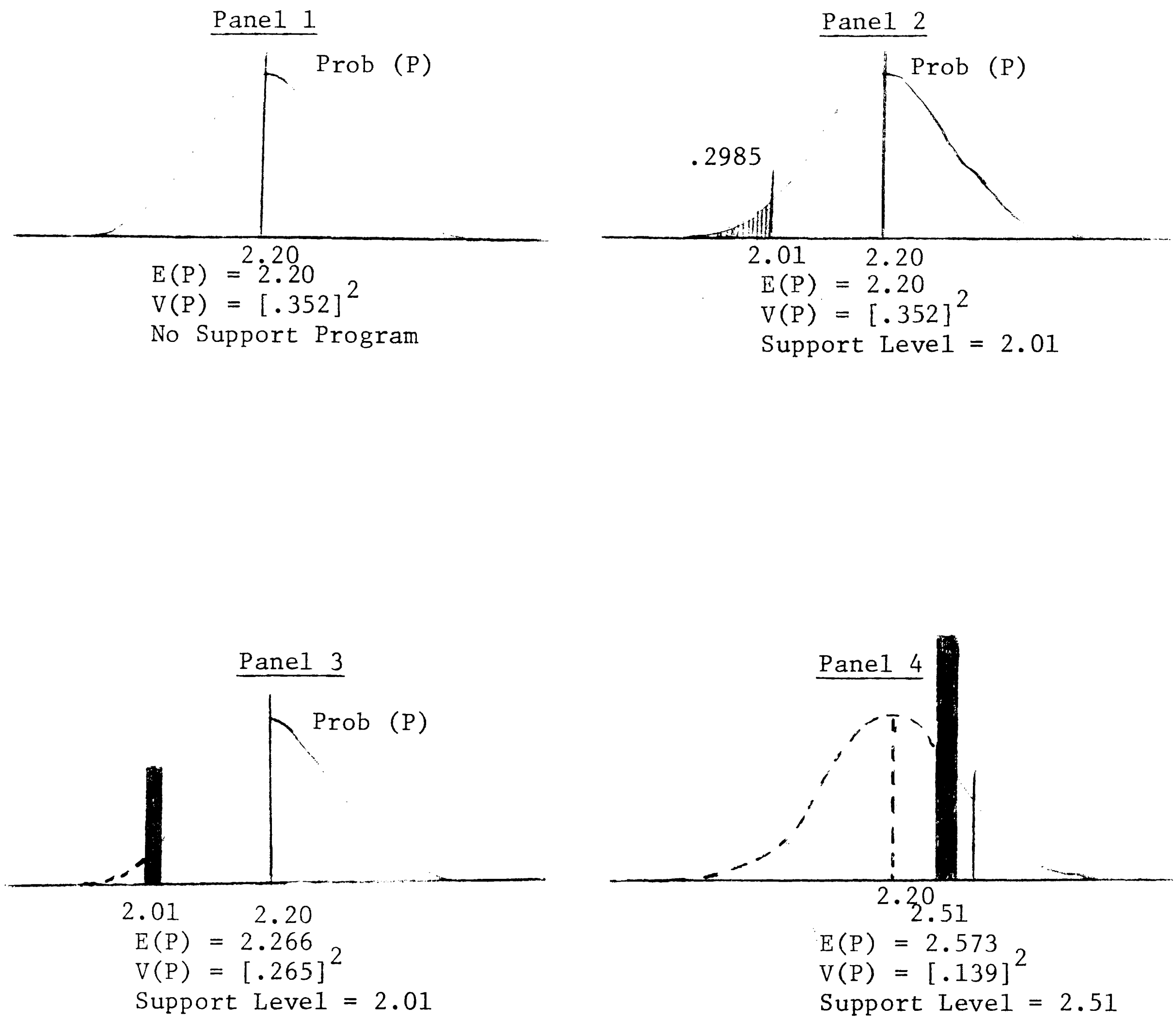
Figure 1. The Simulation Model



program parameters including the farm size and financial structure, efficiency characterisitcs, lending constraints, inflation rates, and government support program parameters. Then, the cost of production per unit of output (corn) is calculated using budget information on the quantities of various input items, output as determined by the production function, and the inflation parameter to reflect increased costs attributable to input price increases.

This cost of production information is then combined with parameters describing the government support price program (cost items to be included in the support level calculation, assumed management and land charge included in the support level, and the percent of total cost per unit covered by the support program) to determine the actual level of the government support price per unit of output. This support price is then inputted into a price expectations model which includes a dynamic price adjustment mechanism tied to the support price. Figure 2 illustrates the adjustment mechanism included in the model. Panel 1 of Figure 2 indicates the original price distribution that the producer faces (without a price support program) and the resulting mean and variance of this distribution. But, through the government price support program, the left-hand tail of the distribution is truncated. The truncated portion of the original distribution is then "stacked" at the support level as illustrated in Panel 3 of Figure 2. This revised distribution now has a higher mean (first moment) and lower variance (second moment) than the original distribution, thus increasing the expected income, lowering the capitalization rate and increasing the value of land and the firm. If the government program includes a land charge in the computation of the cost of production, the increased land value will enter the support price program in the following year and result in a higher support level. As input price inflation and increasing land values spiral upward the cost of production, more of the price distribution

Figure 2. The Support Price and Price Distribution Adjustment Mechanism.



is truncated, expected income rises and the variance declines further as illustrated in Panel 4 of Figure 2. Thus, the indexing impact of the government support price program is clear.

Once the price expectations information has been generated, the annual income above variable costs and taxes can be calculated using the production efficiency budget and price information. This income figure adjusted for income taxes, along with the opportunity cost of capital as adjusted by the aforementioned changes in the variance of the price distribution, mortgage interest rates, expectations of future gains in land values and income per acre are used to determine the value of land using capitalization concepts. This new land value (and assumed market price) along with the income generated this year is used to adjust the financial statement and determine the value of the firm. Finally, the acquisition of additional production assets using earnings after consumption and additional debt as constrained by the debt-equity and repayment ratios occurs. This completes one year of the analysis and the program returns to the initial calculations and cycles through the computations for succeeding years.

The various parameters and farm situations included in the analysis are summarized in Table 1. With respect to the three different farm types, Farm A is typical of the young beginning operator with a 160 acre land base and only a 30 percent equity in his unit. Farm B represents a more typical operator who has an average size unit and 50 percent equity in his operation. Farm C represents a well established farmer with a sizeable operation and a relatively low debt obligation (a 30 percent debt to equity ratio).

In this analysis, each "farm situation" is assumed to be the only type of farm affecting the national cost of production and participating in the land market. For example, Farm A, it is assumed, does not compete for land or have its land value and cost of production affected by Farm C-type participants. It is also assumed unnecessary for the individual case farm to purchase more land every year in order for land values to exist or even rise.

Table 1. Parameter Values and Initial Conditions

Parameters[a]

Expected Inflation rates in:		
Production Costs θ_1		6%
Price Received θ_2		2%, 4%
Net Income Per Acre GNI		3%
Land Price GLV		5%
Price Distribution (Initial)		
Expected Price (Mean) P_t^*		\$2.00
Variance $\sigma^{2*}_{P_t}$		$[.32]^2$
Support Program		
Percent of Cost of Production[b]	¶	80%, 90%, 100%
Initial Support Program	SL_o	\$2.00
Mandated Return to Land[c]		1.5%, 3.5%
Capitalization Rate		
Risk-free Opportunity Costs	ω	5.845%
Long-Term Mortgage Rate	η	8.75%
Short-Term Interest Rate for Other Debt	MR	10.00%

Initial Conditions[a]

Land Price \$1770

Farm Characteristics

	Farm A	Farm B	Farm C
Size (acres)	160	320	640
Assets	\$335,700	\$673,400	\$1,342,800
Liabilities	\$234,990	\$336,700	\$402,840
Equity	\$100,710	\$336,700	\$939,960
Annual Debt Service	\$22,368	\$33,586	\$43,346
Average Tax Rate[d]	11%	16%	25%
Efficiency Premium	\$0.00	\$15.00	\$15.00
Risk Parameter[e]	.68E-9, 1.31E-9	1.698E-10, 3.275E-10	4.246E-11, 8.187E-11

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[a] Where multiple parameter or initial condition values are listed, additional computer analyses were completed to indicate the sensitivity of the results to these different values.

[b] The proportion of the calculated cost of production that will be supported by the support price program.

[c] The return on the current land value that is to be included in the cost of production calculation for the support price program. Land taxes and maintenance costs of 1.5% must be subtracted to obtain net return.

[d] The marginal tax rate is double the average tax rate.

[e] The risk parameter is used in the determination of the annual capitalization rate. The capitalization formula in the model was specified as $c = a + b\,\sigma^2_R$ where c is the capitalization rate, a is the risk free rate and b is the risk parameter. No empirical data is available to specify a priori the value of b, so an implicit value was calculated by specifying a risk-free rate and a risk inclusive rate based on recent market phenomena. The risk-free rate was specified as 5.845% and the initial opportunity cost of capital at 8 and 10%. Thus, for example, the risk parameter is calculated for the Farm A and and 8% rate as .68E-09 (scientific notation).

Undoubtedly, the real-world situation is more complicated, but some useful insight can be discerned given these abstractions from reality.

Numerical Results

The numerical results generated by the simulation model are presented in Tables 2-8. Tables 2 and 3 summarize the costs, prices, land values, farm growth, and financial characteristics for the three farms using the "base" set of government support price program assumptions. The sensitivity of the results to different financial conditions, alternative rates of land return included in the cost of production, the percent of cost of production supported by the government program, various inflation rates in prices, and the risk parameter are summarized in Tables 4, 5, 6, 7 and 8, respectively.

The "Base" Case

The "base" case assumes 90 percent of the cost of production is supported by the government with a price support program, the gross return to land calculated in the cost of production is 3.5 percent of the current market value, expected inflation in corn prices is 2 percent, and the risk parameter is calculated based on an 8 percent opportunity cost of capital. Annual costs, commodity prices and bid prices for land for a 20 year planning horizon are summarized in Table 2 for the three firms analyzed. For example, for the smaller, highly leveraged farm, the total non-land costs in year 1 amount to $1.455 per bushel, and the land costs total $.563 per bushel - resulting in a total cost of production per bushel of $2.018. Based on the price distribution utilized in the analysis, the expected price in the first year is $2.127 with a standard deviation of $.1875. Note that this modified price distribution is over 6 percent higher in expected price and 65 percent lower in variance than the original "free market" price distribution. The support price is set at $2.00 in the first year in accordance with current Administration and Senate proposals. Based on a 110 bushel per acre yield and the costs indicated earlier, the annual net income attributable to the land resource is $91.08 per acre. Using the risk parameter of Table 1 for this firm and a capitalization formula (Lee and Rask, 1976), an implicit capitalization rate of 3.888 percent is estimated.[3/] This combination of annual net return and capitalization rate results in a bid price for land per acre of $2,343 for the small unit.

Note that in subsequent years of the planning horizon the increase in input prices due to inflation results in an increase in non-land costs. Furthermore, the land charge increases because of the 3.5 percent mandated return to land that is part of the government support price program. Total costs of production increase to $6.03 per bushel by year 20. Thus, the cost of production approach to determining support prices along with increases in per unit cost due to inflation result in a three-fold increase in the support price for corn. As indicated in Figure 2, this increase in the support price level truncates the left tail of the price distribution, increasing the expected price and decreasing the variance of price and the variance of return. Even though costs may increase faster than prices, resulting in a reduction in net return as in year 2 for the smaller operator (Table 2), the reduced variance lowers the capitalization rate so that the bid price for land actually increases.

Given the parameters specified for this analysis, the price distribution for the smaller operator collapses to the support price by the fourteenth year so that the price expectation is the support price of $3.798. By the twentieth year of the planning horizon, land values have been pushed to $7,052 per acre by the support price program for the smaller farm. The

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[3/] The income capitalization rate can be and is below the risk-free rate of return because the capitalization rate is reduced by the expected growth rate in the value of land.

Table 2. Costs of Production, Government Price Supports, Expected Prices, Income and Land Values By Farm Situation and Year of Simulation

Year of Simulation	Non-Land Costs ($/bu)	Land Costs ($/bu)	Total Cost of Production ($/bu)	Gov't. Support Price ($/bu)	Expected Price Received ($/bu)	St'd. Dev. of Expected Price ($/bu)	Net Income ($/acre)	Land Capitalization Rate (Percent)	Land Bid Price ($/acre)
Initial Values	1.455	0.563	2.018	2.000	2.000	.3200	xxxx	xxxx	1770
					Farm A				
1	1.455	0.563	2.018	2.000	2.127	.1875	91.084	3.888	2343
2	1.543	0.738	2.281	2.053	2.177	.1868	82.079	3.257	2520
3	1.630	0.786	2.416	2.175	2.266	.1629	83.020	3.138	2645
4	1.725	0.817	2.542	2.288	2.356	.1428	84.530	3.077	2747
5	1.825	0.840	2.666	2.399	2.450	.1248	86.361	3.040	2841
10	2.425	0.948	3.373	3.036	3.043	.0505	102.131	3.009	3394
15	3.240	1.265	4.505	4.054	4.054	.0257	156.580	3.151	4970
20	4.341	1.742	6.083	5.474	5.474	.0314	217.867	3.090	7052
					Farm B				
1	1.455	0.563	2.018	2.000	2.127	.1875	106.084[a]	4.302	2466
2	1.543	0.777	2.320	2.088	2.195	.1748	97.316	3.485	2792
3	1.632	0.871	2.502	2.252	2.316	.1370	99.633	3.267	3049
4	1.729	0.942	2.670	2.403	2.442	.1069	103.202	3.152	3274
5	1.831	1.001	2.833	2.549	2.572	.0831	107.439	3.085	3483
10	2.443	1.252	3.695	3.326	3.326	.0301	135.577	2.997	4524
15	3.260	1.531	4.791	4.312	4.312	.0249	174.751	3.002	5821
20	4.352	1.888	6.240	5.616	5.616	.0322	228.378	3.021	7560
					Farm C				
1	1.455	0.563	2.018	2.000	2.127	.1875	106.084[a]	4.589	2312
2	1.543	0.728	2.271	2.044	2.172	.1898	97.045	3.709	2616
3	1.630	0.816	2.446	2.201	2.282	.1538	98.454	3.428	2872
4	1.726	0.887	2.613	2.352	2.402	.1223	101.355	3.256	3113
5	1.829	0.952	2.780	2.502	2.532	.0950	105.285	3.143	3350
10	2.443	1.265	3.708	3.337	3.338	.0299	136.261	2.951	4617
15	3.265	1.612	4.877	4.389	4.389	.0252	180.134	2.922	6165
20	4.361	2.028	6.388	5.750	5,749	.0329	238.136	2.929	8131

[a] Note that Farm B and Farm C benefit from a $15/acre efficiency due to operator experience and economies of size.

same phenomenom occurs for the typical (Farm B) and larger (Farm C) units where land values have increased to $7,560 per acre and $8,131 per acre, respectively. The data of Table 2 indicate that over time the larger, lower leveraged farm can continually pay a higher price for the land than the smaller, highly leveraged unit. This is primarily do to a higher residual return to land based on economies of size in operation. So the government support price program would improve the bidding potential of the larger high-equity farm units compared to smaller low-equity farms over time.

The financial and growth implications of the government support program for the three representative firms are summarized in Table 3. For the smaller unit, firm size in acres remains unchanged for the first ten years even though total assets and net worth increase dramatically due to increases in the value of land. Other assets also increase as inflation pushes up the value of durable inputs such as machinery and equipment. In fact, net worth increases almost three-fold during the first ten years due primarily to asset appreciation. In the eleventh year of the planning horizon sufficient cash is generated to begin the acquisition of additional land. Over the next ten years a total of 50 additional acres are added to the farm unit. By the end of the planning horizon net worth totals $1,082,855 and the debt to asset ratio is .34. By the twentieth year, the growth rate appears to have stabilized around 12 percent per year. Family living has also reached a reasonable level after having been at the minimum level of $5,000 per year for the first seven years of the planning horizon.

The 320 acre farm expands acreage much more quickly and to a larger relative size compared to the smaller unit as indicated in Table 3. Approximately 20 additional acres of land are added to the 320 acre farm in the second period of the planning horizon, and by the 20th year acreage has increased to 485 acres. Total equity has increased to $2,827,608 by

Table 3. Income, Assets, and Debt Statement by Farm Situation and Year of Simulation

Year	Income Less Taxes	Family Consump-tion	Total Land Value	Acres In Firm	Other Assets	Total Assets	Total Debt	Total Equity	Annual Growth Rate in Equity	Debt to Asset Ra
					Farm A					
1	2,347	5,000	374,810	160	54,056	428,866	256,502	172,364	53.74	0.5981
2	2,049	5,000	403,260	160	55,361	458,621	273,059	185,561	30.56	0.5954
3	2,436	5,000	423,240	160	55,733	478,973	285,684	193,289	21.73	0.5965
4	2,838	5,000	439,588	160	55,645	495,233	295,186	200,046	17.16	0.5961
5	3,255	5,000	454,483	160	55,490	509,973	302,213	207,759	14.48	0.5926
10	6,080	6,206	542,989	160	62,243	605,232	314,887	290,345	10.59	0.5203
15	12,144	9,334	879,452	177	90,456	969,908	375,878	594,030	11.83	0.3875
20	17,419	11,547	1,484,070	210	156,295	1,640,365	557,510	1,082,855	11.88	0.3399
					Farm B					
1	961	5,000	789,135	320	110,865	900,000	365,832	534,167	46.15	0.4065
2	-979	5,000	952,007	341	105,471	1,057,478	432,924	624,555	30.89	0.4094
3	472	5,000	1,039,720	341	108,883	1,148,603	451,071	697,532	24.28	0.3927
4	1,964	5,000	1,116,354	341	112,825	1,229,180	464,178	765,001	20.52	0.3776
5	3,572	5,000	1,187,513	341	118,048	1,305,561	473,298	832,263	18.10	0.3625
10	9,984	8,315	1,669,169	369	145,769	1,814,938	586,728	1,228,210	12.94	0.3233
15	17,819	11,703	2,424,070	416	214,006	2,638,076	797,936	1,840,140	11.32	0.3025
20	27,069	14,977	3,670,260	485	358,458	4,028,719	1,201,111	2,827,608	10.64	0.2981
					Farm C					
1	20,583	12,742	1,479,583	640	233,800	1,713,383	434,216	1,279,166	30.81	0.2534
2	12,816	9,635	2,008,316	768	208,401	2,216,717	713,821	1,502,896	23.47	0.3220
3	10,733	8,678	2,409,779	839	197,465	2,607,244	900,232	1,707,012	19.89	0.3453
4	11,653	9,109	2,704,332	869	203,046	2,907,378	996,232	1,911,145	17.74	0.3427
5	14,506	10,365	2,944,391	879	219,461	3,163,852	1,039,231	2,124,621	16.31	0.3285
10	33,511	16,988	4,380,388	949	346,898	4,727,286	1,279,355	3,447,931	13.00	0.2706
15	52,977	22,258	6,720,444	1,090	573,788	7,294,233	1,889,820	5,404,413	11.66	0.2591
20	76,484	27,643	10,499,164	1,291	958,834	11,457,998	3,076,527	8,381,471	10.94	0.2685

the 20th year for this farm and the debt to asset ratio has declined from 50% to slightly less than 30% during this period. Note that the debt to asset ratio decreases more slowly for the 320 acre unit compared to the smaller firm primarily because it is acquiring more additional acreage compared to the smaller unit. The average annual growth rate for Farm B over the 20 year period is 10.64% which is lower than that of Farm A.

The support price program enables the larger farm (Farm C) to more than double its acreage during the 20 year planning horizon, even though it must pay a higher price for the land. Acreage increases from 640 acres in the first period to 1291 acres by the 20th year. Net worth has grown to in excess of 8 million dollars by the 20th year, and the debt to asset ratio has declined to .2685. The annual rate of growth is again about 11% per year for the large, high equity unit. Note that family living for this farm is always in excess of the minimum acceptable amount of $5,000 and expands to $27,643 by the 20th year.

Thus, the government support price program enables the larger, higher equity farm to expand more rapidly than the smaller, highly leveraged unit in terms of the land base. Growth in net worth is not significantly different between the three farms, but the level of family living is also higher for the larger unit. In essense, the government support price program improves the guaranteed cash flow of the larger compared to the smaller unit, and this combined with the lower debt servicing requirement and larger amount of uncommitted cash from current land holdings enables the larger farmer to expand his land base more rapidly, pay a higher price for the land and enjoy a higher level of consumption and family living.

Sensitivity Analysis

One possible explanation for the differences in expansion rates and financial growth between the large, high equity and small, low-equity farms summarized earlier might be the initial equity position and debt servicing obligation rather than the government support price program. Table 4 summarizes the financial characteristics and growth of the firm assuming all three units have initial debt to asset ratios of .30 and .70. Note that with a 30 percent debt to asset ratio, the smaller unit expands its land acreage from 160 to 280 acres (a 75 percent increase) and increases its net worth to approximately $735,000 by the tenth year of the planning horizon. The consumption level increases from $9,675 in year 1 to $14,340 in the twentieth year. In contrast, the two larger farms increase their acreage by approximately 50 percent by year 10 with an initial debt to asset ratio of 30 percent, but the growth rate in net worth exceeds that of the smaller farm with the same leverage ratio. The higher growth rates in equity for the two larger units and the higher bid prices for land compared to the smaller unit are even more evident when the debt to asset ratio is 70 percent for all three farms. In addition the consumption level is higher for the larger units compared to the smaller farm. Thus, even with the same initial financial structure, the government support price program appears to improve financial growth of the larger units compared to the smaller unit, as well as, the standard of living or consumption level.

The impact of alternative mandated returns to land included in the cost-of-production calculations for the government price support program is indicated in Table 5. Note that by the tenth year the support price is increased by approximately $.50 for the smaller unit (Farm A) compared to an almost $.80 increase for the two larger units (Farms B and C) with a

Table 4. Sensitivity to the Initial Equity Position and Debt Servicing Obligation of the Firm, by Farm Situation[a/]

Item	Unit	30 Percent Debt/Asset Ratio			70 Percent Debt/Asset Ratio		
		Farm A	Farm B	Farm C[b/]	Farm A[b/]	Farm B	Farm C
Support Price Level	($/bu)	3.106	3.264	3.337	3.036	3.304	3.321
Capitalization Rate of Land	(%)	3.186	3.045	2.951	3.009	3.013	2.963
Bid Price for Land	($/ac)	3,809	4,318	4,617	3,394	4,452	4,563
Acres Owned by the Firm	(ac.)	280	478	949	160	320	640
Total Assets	($1000)	1,169	2,238	4,727	605	1,533	3,137
Total Liabilities	($1000)	434	688	1,279	314	639	1,186
Equity	($1000)	735	1,550	3,448	290	893	1,951
Annual Growth in Equity	(%)	11.40	11.90	13.00	10.59	14.87	15.77

[a/] Results are drawn from year 10 of the simulation results.

[b/] Base situation

Table 5. Sensitivity to the Return of Land Mandated in the Cost of Production by the Government Price Support Program[a]

		Farm A		Farm B		Farm C	
Item	Unit	1.5%	3.5%	1.5%	3.5%	1.5%	3.5%
Support Price Level	($/bu)	2.433	3.036	2.466	3.326	2.458	3.337
Capitalization Rate of Land	(%)	2.595	3.009	2.680	2.997	2.699	2.951
Bid Price for Land	($/ac)	2,178[b]	3,394	2,591[c]	4,524	2,592[d]	4,617
Acres Owned by the Firm	(ac.)	160	160	341	369	878	949
Total Assets	($1000)	449	605	1,055	1,815	2,660	4,727
Total Liabilities	($1000)	328	315	501	587	1,021	1,279
Equity	($1000)	120	290	554	1,228	1,639	3,448
Annual Growth in Equity	(%)	1.78	10.59	4.97	12.94	5.56	13.00

[a] Results are drawn from year 10 of the simulation results.

[b] A downward inflexible land market assumption would hold the land price to $2467/acre.

[c] A downward inflexible land market assumption would hold the land price to $2755/acre.

[d] A downward inflexible land market assumption would hold the land price to $2681/acre.

3.5 percent compared to a 1.5 percent mandated land return included in the cost-of-production. The bid price for land increases by approximately $1200 for the smaller, highly leveraged unit compared to almost $2,000 for the two larger units with the higher land return. Thus, the larger units would tend to be more successful bidders in the real estate market with the higher mandated return. The guaranteed cash flow implications of the higher mandated return to land as evidenced by additional land acquisition is also illustrated in Table 5. With a 3.5 percent mandated return to land, the smaller, highly leveraged unit cannot acquire additional land during the first ten years of the analysis, whereas the larger, high-equity unit can expand from 640 acres to 949 acres. This compares to an expansion to 878 acres if the mandated land return is only 1.5 percent.

Note the dramatic differences in the rate of equity growth for each farm assuming different returns to land are included in the cost or production. In terms of rate of growth in equity, the smaller, highly leveraged firm receives the major benefit of a higher mandated return to land in the government price support program. The growth rate increases from 1.78 percent per year with a 1.5 percent mandated return to 10.59 percent per year with a 3.5 percent return. The larger firm (Farm C) also exhibits a higher growth rate with the 3.5 percent mandated return to land, but the increase in growth rate is not nearly as dramatic. So the higher mandated return enables the larger, higher equity firm to bid more for land and acquire more land resources compared to the smaller, high-leveraged unit, but the benefits in terms of rate of equity accumulation are much larger for the smaller, highly leveraged unit.

The implications of different rates of cost protection through the government support program are illustrated in Table 6. For example, if the government support price program only covers 80 percent of the cost-of-production, the support price in year 10 for Farm A is only $2.49 compared to a $4.38 support price if 100 percent is covered. The implications of different cost-of-production percentages included in the support price program for land prices are also clearly illustrated by the data in Table 6. Tenth year land values are in the $7,000-8,000 range if 100 percent of the cost-of-production is supported by the government program compared to $2,500-3,000 if only 80 percent of production costs are covered by the support price program. The financial consequences of alternative rates of coverage are also apparent from Table 6. For the small, highly leveraged farm, the rate of annual growth in equity accumulation increases from approximately 2 percent per year with the 80 percent coverage to over 22 percent per year with the 100 percent coverage. Equity accumulation by year 10 increases from $123,000 to $959,000 with shifts in the government program from 80 to 100 percent coverage. In similar fashion, the rate of equity accumulation for the two larger firms also increase dramatically as the percent coverage increases from 80 to 100 percent.

The primary benefactor of the higher percentage coverage in terms of rate of growth is again the smaller, highly leveraged unit. Even though this unit is not capable of expanding its acreage base with the guaranteed cash flow generated by a 100 percent cost of production support price program, the value of the real estate it does own increases sufficiently to result in a dramatic rate of equity accumulation. In contrast, the larger unit is able to expand from its initial 640 acre size to 1,023 acres with the guaranteed cash flow generated by the 100 percent cost of production support program. The additional real estate acquired plus the increase in value of the initial land endowment results in an increase in the equity position

Table 6. Sensitivity to the Percent of the Costs of Production Supported by by the Government Price Support Program[a]

		Farm A			Farm B			Farm C		
Item	Unit	80%	90%	100%	80%	90%	100%	80%	90%	100%
Support Price Level	($/bu)	2.493	3.036	4.385	2.563	3.326	4.596	2.552	3.337	4.461
Capitalization Rate of Land	(%)	2.690	3.009	3.218	2.830	2.997	3.166	2.825	2.951	3.210
Bid Price for Land	($/ac)	2,467	3,394	7,163	2,757	4,524	7,768	2,713	4,617	7,357
Acres in Farm	(ac.)	160	160	187	341	369	420	902	949	1,023
Total Assets	($1000)	449	605	1,410	1,055	1,815	3,426	2,761	4,727	7,930
Total Liabilities	($1000)	326	315	451	491	587	834	1,078	1,279	1,746
Equity	($1000)	123	290	959	564	1,228	2,593	1,683	3,448	6,183
Annual Growth in Equity	(%)	1.97	10.59	22.54	5.16	12.94	20.41	5.82	13.00	18.84

[a] Results are drawn from year 10 of the simulation results.

of the firm from 1.2 million dollars at the beginning of the planning horizon to approximately 6.18 million dollars in the tenth year. This compares to an increase to 902 acres and a net worth of 1.68 million dollars for the large firm if an 80 percent cost of production guarantee is included in the government support program. So land values, financial growth and equity accumulation are very sensitive to the percent of the cost-of-production guarantee included in the government program. In addition, the benefits in terms of rate of equity accumulation of the higher guarantee are larger for the small unit compared to the large unit, but not in terms of rate of land acquisition.

The sensitivity of the results to different rates of inflation in prices is summarized in Table 7. The "base" set of assumption included a 2 percent rate of inflation for expected corn prices (i.e. the mean of the original price distribution unmodified by any support program); the alternative rate of 4 percent was also analyzed. A higher rate of inflation in expected "market" prices lessens the impact or "effectiveness" (in terms of truncating the price distribution, increasing the mean expected price and lowering the price risk) of the government price support program over time. With a higher inflation rate, the post-program price distribution is more slowly, or less likely overcome by the cost of production-fed price support program. The results of Table 7 indicate that for the two smaller size firms (Farms A and B), the higher inflation rate results in a higher bid price for land, more total assets, a large equity and a faster rate of growth in equity. For the larger farm, the higher inflation rate actually impedes the rate of growth and equity accumulation of the firm, since it is proportionately more sensitive to price risk. The benefits of the higher inflation rate seem to be the largest for the smaller, higher leverage

Table 7. Sensitivity to Inflation Rate in Expected Prices Received for Corn[a/]

		Farm A		Farm B		Farm C	
Item	Unit	2%	4%	2%	4%	2%	4%
Support Price	($/bu)	3.036	3.119	3.326	3.356	3.337	3.316
Capitalization Rate of Land	(%)	3.009	3.152	2.997	3.062	2.951	3.098
Bid Price for Land	($/ac)	3,394	3,690	4,524	4,613	4,617	4,495
Acres Owned by the Firm	(ac)	160	160	369	377	949	964
Total Assets	($1000)	605	659	1,814	1,885	4,727	4,684
Total Liabilities	($1000)	315	315	587	618	1,279	1,325
Equity	($1000)	290	344	1,228	1,267	3,448	3,359
Annual Growth Rate In Equity	(%)	10.59	12.29	12.94	13.25	13.00	12.74

a/ Results are drawn from year 10 of the simulation results.

unit where the growth rate is increased by almost 2 percentage points. Although the smaller unit is not able to expand its acreage under either inflation assumption by the tenth year, it has accumulated more equity under the 4 percent inflation rate. The inflation rate assumption appears to leave much less effect on the bid prices, land values and financial growth than the other model parameters.

The implications of different risk parameters for the three different sizes of firms are summarized in Table 8. With the larger risk parameter and the higher aversion to risk, the capitalization rate increases for all three firms and the cost-of-production-fed support price declines. The lower support price results from the lower land price (due to the higher capitalization rate) being used to calculate the support level. With a lower support price and higher capitalization rate, the bid price for land also declines for all three firms. However, note that the increase in capitalization rate, the decrease in support price and the decrease in the bid price for the land is significantly larger for the smaller firm compared to the larger units. Thus, changing the risk aversion parameter has more impact on bid prices for the smaller, highly leveraged unit compared to the larger units. The implications of a higher level risk aversion are also clearly illustrated in the differences in the equity capital accumulation and rate of growth for the three firms. For the smaller firm, a total equity capital of $290,000 is accumulated by the tenth year with a risk aversion parameter based on an 8 percent opportunity cost of capital compared to $132,000 with the higher risk parameter associated with the 10 percent opportunity cost of capital. The annual growth rates amount 10.59% for the smaller risk parameter compared

Table 8. Sensitivity to the Risk Parameter Adjusting the Opportunity Cost of Long-Term Capital[a/]

		Farm A		Farm B		Farm C	
Item	Unit	.68E-9	1.31E-09	1.698E-10	3.275E-10	4.246E-11	8.187E-11
Support Price Level	($/bu)	3.036	2.758	3.326	3.301	3.337	3.277
Capitalization Rate of Land	(%)	3.009	3.583	2.997	3.015	2.951	3.002
Bid Price for Land	($/ac)	3,394	2,429	4,524	4,444	4,617	4,408
Acres Owned by the Firm	(ac)	160	160	369	369	949	958
Total Assets	($1000)	605	447	1,815	1,784	4,727	4,572
Total Liabilities	($1000)	315	315	587	581	1,279	1,273
Equity	($1000)	290	132	1,228	1,203	3,448	3,299
Annual Growth Rate in Equity	(%)	10.59	2.68	12.94	12.73	13.00	12.55

[a/] Results are drawn from year 10 of the simulation model.

to 2.68 percent for the larger risk parameter for the smaller, highly leveraged firm. Thus, the higher level of risk aversion has a significant dampening effect on the rate of growth and capital accumulation capability of the smaller firm. In contrast, the two larger firms exhibit relatively small differences in the equity accumulation and rates of growth by the tenth year of the planning horizon for the different risk parameters. Consequently, higher levels of risk aversion have a much larger effect on growth and expansion for the smaller, highly leveraged unit compared to the larger units.

Conclusions and Implications

The current proposals to index government support prices based on the cost of production will have a significant impact on the agricultural sector. The results summarized here indicate that with current price expectations and government program parameters and conservative inflation rates, the cost-of-production based support price mechanism could increase land prices dramatically within a short period of time. Although all current land owners receive the benefit of the capital gain that would result, the larger, high equity operator is the only one able to pay the higher price for additional land. Futhermore, the guaranteed cash flow that results from such a support price program is much greater for the larger, high equity farmer, so he can utilize more debt to acquire the land and service the debt without impairing his consumption level. So the great majority of the benefits of such a program goes to the larger producers.

The results also suggest that the government program parameters, such as the manadated return to land calculated as part of the cost of production and the percent of the production costs covered by the program can have a major impact on price expectations, land values, land acquistion and equity accumulation. The analyses completed here further verify the conclusion that

> "Cost-of-production pricing is bedeviled by numerous pitfalls, and implementation of the concept by supporting farm prices at a level that will give all farmers a parity return on resources is simply not feasible. The level at which farm prices would need to be set to cover the cost of production is highly arbitrary--it all depends on which size of farm is chosen to establish the standard. The price of land is in fact determined partly by prices received by farms. Increasing commodity prices to pay the cost of farm real estate will lead to higher land prices and the need (or trigger) to support commodity prices at even higher levels." (Tweeten, p.167)

Policymakers should carefully evaluate the cost of production concept and program parameters because the financial consequences of eliminating or phasing out such a price support program once it has been implemented, capitalized into the land market, and built into the price and risk expectations of producers and other landowners could be financially disastrous. Furthermore, equity increases and accumulation in fixed assets such as land due primarily to rising asset values does little to improve the standard of living of those farm families who own real estate, and increased land values certainly increase the already difficult problems of entry into the agricultural sector and intergenerational transfers.

Lastly, this study offers the challenge to determine the micro impact of policy alternatives and to quantify the many relevant and sensitive parameters, linkages, and economic processes partially developed in this analysis. Adequately quantifying and modelling producer expectation of future values of economics variables and how these expectations are modified by deviations from expectations or external policies and programs are difficult tasks. Incorporating risk and uncertainty dimensions into investment decisions and planning for the firm is not a new issue, but much additional research needs to be done. As usual, tasks which begin by asking for a simple answer to a question inevitably stimulate inquiry and the need for new information on much broader issues.

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