Valuation of U.S. Agricultural Support Programs: A Contingent Claims Analysis Approach

by

Viswanath Tirupattur and Robert J. Hauser

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Provision of government subsidies through price and/or income support programs has been an important component of U.S. agriculture since the passage of the Agricultural Adjustment Act (AAA) of 1933. Outlays expended under the different agricultural support programs in the last 10 years have been substantial, ranging from $4 billion to over $20 billion.

Given the size of the support program expenditures, policy makers are frequently considering alternative means of structuring and implementing the programs. A significant initiative in the Food Security Act of 1985 mandated a study of alternative price stabilization and risk management mechanisms for farmers through alternatives existing in the private sector, such as futures and options markets. The act states that "... there is a need for investigation and development of alternative price support programs carried out by the Department of Agriculture; that agricultural producers and others have insufficient knowledge concerning the nature and extent of price stabilization in the private sector; and that more information is needed to accurately assess the impact of producer participation in such private sector risk avoidance services" (p. 591). This mandate led to the Congressional authorization of the U.S. Department of Agriculture (USDA) through the Food, Agriculture, Conservation and Trade Act (FACTA) of 1990 to conduct an Options Pilot Program (OPP) to determine whether regulated commodity options trading can be used by producers to obtain protection from fluctuations in market prices of commodities and to determine the impact of such trading on the price of the commodities (subtitle E of title XI). In 1993, an OPP was implemented in 3 counties each in Illinois, Indiana and Iowa. In 1994, the program was expanded to include more commodities and states.

In the academic literature, the use of futures and option markets in government programs has been discussed mostly in conceptual and qualitative terms (e.g., Gardner; Randall). Gardner viewed the price support programs as a fully subsidized insurance scheme provided by the tax-payers to the agricultural producers. He suggested the introduction of a system where producers pay for the insurance an amount equal to the expected value of deficiency payments. He likened the deficiency payments to traded put options, where the government is the writer of the contract. In the context of the European Community, Gemmil recommended a series of put options engineered to the needs of farmers to insure against price risk and be paid for by the farmers or the government. Petzel suggested a private- market orientation to U.S. agricultural policy through widespread use of futures and options markets to provide the insurance that is being provided by the government through price and income support programs.

An important consideration in evaluating alternative price and income support mechanisms is the value of existing programs. Presumably, an accurate valuation of the

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[1]Department of Agricultural Economics, University of Illinois at Urbana-Champaign. Tirupattur is a Graduate Research Associate. Hauser is Professor of Agricultural Economics and Research Associate of the Office for Futures and Options Research.

existing subsidy programs would be an important consideration in evaluating alternative mechanisms. Such a valuation may indicate the "market price" of the existing commodity programs, and could be used to compare the economic cost of traditional support programs with the cost of an OPP.

In principle, agricultural subsidies are not unlike other governmental guarantees of private debts. Valuation of such governmental guarantees has been of significant interest in the finance literature. Merton (1977) demonstrated the isomorphic equivalence of the Federal Deposit Insurance Corporation (FDIC) deposit insurance to an European put option. Mason and Baldwin also use option valuation theory to estimate the cost of a loan guarantee to a generic large-scale synthetic fuel plant. Sosin applied contingent claims analysis to value federal loan guarantees to corporations. Sherrick developed a valuation model for Federal loan guarantee programs through the Farmers Home Administration (FmHA). Jones and Mason used numerical methods and option pricing theory developed by Merton (1974) to tabulate values of loan guarantees under different firm conditions.

With respect to agricultural subsidy programs, Marcus and Modest developed a valuation formula for the U.S. agricultural price support system by modifying the Black-Scholes formula for valuing European puts. Turvey applied contingent claims analysis using the Black-Scholes model for the valuation of Canadian agricultural stabilization and insurance policies. Kang and Brorsen modelled the target price support programs using a GARCH average option pricing framework. Even though several other agricultural economists have pointed out the "option-like" features of U.S. commodity programs (Gardner; Hauser; Heifner and Sporleder; Kahl; Schertz), an explicit valuation of the farm programs taking into consideration the several "exotic" option features has not yet been done. The primary objective of the present analysis is to extend previous work by focussing on the exotic option features implicit in the U.S. farm programs. A case application of the resulting model compares the value of the government programs to that of an exchange put offered under OPP.

A Description of the Contingent Claims in U.S. Farm Programs

Currently three basic instruments are used to meet U.S. farm policy objectives: target prices, loan rates and acreage reduction programs[2]. These instruments translate into price and income support programs which can be viewed as three different types of contingent claims; namely, loan payments, deficiency payments and Findley payments[3]. Of these, deficiency payments constitute the bulk of the government support payments made to farmers. Each of these three "contingent claims" programs is described below.

Loan payments refer to the loans made by the government to participating farmers at the basic loan rate (per unit of quantity). The term of the loan is typically for 9 months. A participating farmer can obtain a loan at harvest (and a period thereafter) from the

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[2]A fourth important program subsidizes importers of U.S. feed and food grains through the Export Enhancement Program (EEP).

[3]There are additional categories of contingent payments made to farmers(marketing loan gain and loan deficiency payments) which are relatively minor and are ignored in this discussion.

Commodity Credit Corporation (CCC) for the quantity of crop produced. During the 9 month term, the farmer can choose to sell the produce any time at the market price and repay the loan. If the market price is not attractive to the farmer (i.e., below the loan rate) repayment can be in kind by forfeiting the quantity to the CCC. In other words, the payoff to the participating farmer can be expressed as:

(1) $$LP=Max(P_t,BLR)*\tilde{q}$$

where LP is the payoff of the loan program, P_t is the market price at the time when the decision to sell is made, BLR is the basic loan rate and $\tilde{q}$ is the quantity placed under loan.

There is no limit to the quantity that can be used as a collateral with the CCC for obtaining the loan. Note that at the time of program sign-up (typically at or before planting) the quantity that will be produced is unknown. Thus there are two state variables determining the payoff from this contingent claim -- market price and quantity of production. Further, the "option" can be exercised during the term of the contract (say, 9 months after harvest) at any time. Thus the option has a "Mid-Atlantic" feature in that it is European until harvest and American after harvest during the term of the loan.

The second contingent claims program involves deficiency payments made to farmers. The payment rate per bushel (or other unit of quantity) is based on the difference between the target price and the higher of the basic loan rate and a national average price. The total deficiency payment received by a farmer is the deficiency payment rate multiplied by eligible production. Eligible production is determined as follows. Each participating farmer is assigned an acreage known as base acres, which is a 5-year moving average of acres planted and considered planted[4] to a particular crop. Typically, some proportion of the base acres is set aside (or idled) for conservation use. The proportion of the base acres to be set aside is announced at the time of program sign-up and has ranged from zero to 25 percent in the recent past, averaging about 10 percent. Each participating farmer is also assigned a specific yield level for each program crop (called program yield) which is based on an historical average for the farmer. This yield is known at the time of sign-up. The quantity of production on which the deficiency payments are made is called "eligible production" and is determined as:

(2) $$EP=(BA-SA)*PY$$

where EP is eligible production, BA is base acres, SA is set-aside acres and PY is program yield. Deficiency payments (DFP) made on this quantity are:

(3) $$DFP=EP*[Max(TP-Max(NP_5,BLR),0)]$$

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[4]Acreage "considered planted" refers to the acres idled as a part of Acreage Reduction Program (ARP), Paid Land Diversion Program (PLD), 0/50 and 0/92 programs. Flex acres provision has not considered in this analysis.

where TP is target price, and NP_5 is the 5 month average of the national price. Deficiency payments per person owing base acres can not exceed $50,000.

At the time of program sign-up, an advance deficiency payment is made which is based on a USDA projection of the 5 month national average price. The advance payment is 40-50 percent of the projected total deficiency payment. About 12 months later, the difference between the advanced deficiency payment and actual deficiency payment is resolved. For corn, program sign-up and the payment of advance deficiency payments takes place during March - April and final payments after adjusting for the advance payments are made in March of the following year. The national 5 month average is computed over the months of September - January.

Thus, the time frame of this contingent claim contract is about one year. Payoffs are contingent upon the 5 month arithmetic average of national prices about 4-5 months after the beginning of the contract and are subject to a limit of $50,000 per participating farmer. The target price, basic loan rate, advance deficiency payment rate, and set-aside proportions are known at program sign-up. Since eligible production is pre-determined and does not depend upon the actual production, the only state variable stems from the stochastic process determining the 5 month national average price. Thus the deficiency payment program is akin to that of an "Asian" (or path-dependent) option with payment caps.

Findley payments are designed to provide additional income support to farmers when market prices are very low. They are similar to deficiency payments in the sense that they are made on the quantity of eligible production. Given the Findley (or reduced) loan rate which is lower than the basic loan rate, Findley payments (FNP) are determined as:

$$FNP=EP*[Max(BLR-Max(NP_{12},FLR),0)] \tag{4}$$

where FLR is the Findley loan rate and NP_{12} is the 12 month arithmetic average of the national prices. There is an upper limit of $75,000 per participating farmer. No advance payments are made for Findley payments. For corn, Findley payments are made in October of the following year and are based on the season average price defined over October - September. Thus the time frame of the contract is about 18 months. As in case of the deficiency payments, Findley payments can also be treated as Asian (path dependent) options with payment caps.

"Exotic" Option Features in U.S. Agricultural Support Programs

The contingent claims associated with U.S. agricultural support programs involve "exotic" option features, distinguishing them from a standard exchange traded option. For the loan payment program, the distinguishing valuation features are: a) random nature of the contracts; b) two state variables or two sources of uncertainty; and c) exercise is European until harvest and American for 9 months thereafter. In the deficiency payment program, the distinguishing features are: a) path dependent payoffs; b) upper limits on the payoffs; and c) the payoff region of the density function is bound on both ends because the basic loan rate acts as a lower boundary for the payoffs. The exotic features in the Findley program are similar to those of the deficiency program.

From an option valuation perspective, another important consideration in valuing deficiency and Findley payments concerns the cost of entering the contract which, for the most part, is the opportunity cost of not producing crops on the set-aside acres. The valuation of this opportunity cost is subject to two state variables: a) market price realized and b) quantity which would have been produced.

Methodology

An explicit derivation of a valuation model for a contingent claim with payoffs dependent on an arithmetic average price process and limited by a constant is available upon request to the authors. This general model can be easily adapted for valuing deficiency and Findley payments.

Defining the arithmetic averaging process as A(t) and the cost of setting aside acres as C, payoffs from the deficiency payments component of the U.S. farm program (DFP) can be expressed as:

(5) $$DFP=Min[50000,(Max(TP-Max(BLR,A(t)),0))*(PY*(BA-SA))]-(SA*C)$$

The time interval over which the A(t) integral operates for the deficiency payments is 5 months (September - January in case of corn). The value of the deficiency payment payoff (f_{DFP}) can be expressed as:

(6) $$f_{DFP}=e^{-r(T-t)}E^{S(t),A(t),t}DFP$$

where r is an annualized risk free interest rate, t is the time at which the payoffs are valued, T is the expiration time, S(t) is the price of commodity at time t and $E^{(\cdot)}$ is the conditional expectation operator with respect to S(t), A(t) and t.

When settlement of the final deficiency payment is made at T, the interest accrual on the advance deficiency payments should be included in the value of the program. Therefore, the value of payoffs from the deficiency payment component equals the value of the contingent claim in (6) plus the present value of interest earned on the advance deficiency payment.

Payoffs from the Findley payment component of the farm program (FNP) can be written as:

(7) $$FNP=Min[75000,(Max(BLR-Max(FLR,A(t)),0))*(PY*(BA-SA))]-(SA*C)$$

where the time interval over which the A(t) integral operates is 12 months (September - August in case of corn). Like equation (6), the payoffs from the Findley payment component can be valued as:

(8) $$f_{FNP}=e^{-r(T-t)}E^{S(t),A(t),t}FNP$$

The combined process (S(t),A(t)) in (6) and (8) does not have analytically tractable properties (Hull), making it impossible to find a closed-form valuation formula for (6) or (8). Thus, numerical approximation methods must be used.

Numerical Valuation of Deficiency and Findley Payments

The numerical valuation is based on Monte Carlo methods introduced by Boyle and used widely elsewhere (e.g. Kemna and Vorst; Hull and White). The general method is numerically efficient, provides standard errors for the estimates and accommodates complex payoff structures. To illustrate the technique, consider the following definite integral:

$$\int_0^{\infty} g(y)f(y)dy=\bar{g}, \tag{9}$$

where g(y) is an arbitrary function (e.g., Max(K-S,0) in the case of a European put option where K is the strike price and S is the terminal stock price) and f(y) is a probability density function such that:

$$\int_0^{\infty} f(y)dy=1. \tag{10}$$

An estimate of g can be obtained by drawing randomly a large number of sample values, y_i and calculating:

$$\hat{g}=\frac{1}{n}\sum_{i=1}^{n} g(y_i). \tag{11}$$

The standard deviation of the estimate, $\hat{s}$, is:

$$\hat{s}=\sqrt{\frac{1}{(n-1)}\sum_{i=1}^{n}(g(y_i)-\hat{g}^2)}. \tag{12}$$

For large n, (n-1) can be substituted by n.

The option pricing problem can be considered a numerical integration problem in calculus. Under no-arbitrage conditions, Cox and Ross showed that European option prices are discounted present values of future payoffs. For example, a put option premium (V_p) can be expressed as:

$$V_p=b(T)\int_0^{\infty}\max(x-Y_T,0)\,f(Y_T)dY_T, \tag{13}$$

where x is the underlying commodity price, f() is the probability density function of the price at maturity and b() is the discount factor. Since the Monte Carlo method can be used to approximate any definite integral, it can be used to value the option in (13) as well as the contingent claims described in (6) and (8).

The method is operationalized as follows. Under the assumption of log-normality, a random sequence of prices is generated by drawing from the standard normal distribution. These random drawings represent price changes which can be used at each time interval to yield a complete price path over time. For each path, contingent payoffs are computed to get a sample value of the payoff. This procedure is repeated a large number of times with independent drawings, yielding a large sample of payoffs. The expected value of the payoff is calculated as the arithmetic average of this sample of payoffs. The present value of this average is the estimated value of the contingent claim.

Independent drawings ensure the Markov property of prices. The sample price paths for the underlying state variable (price) must correspond to the stochastic process that the state variable follows in a risk-neutral world. In this analysis, prices are assumed to follow log-normal distribution and the Monte carlo simulation was performed using 100,000 trials (price paths).

Numerical Valuation of Exchange Put Options

The exchange traded put options are American options and no closed form analytical solutions exist for valuing American options. However, there are several numerical methods available including the binomial method (Cox, Ross and Rubinstein) and quadratic approximation (Barone-Adesi and Whaley). Both of these methods are used here to value exchange puts.

The value of the exchange put is compared to the value of the contingent claims in the government support programs. For both the exchange puts and the government programs the following (corn) parameters are used: target price, \$2.75; basic loan rate, \$1.90; Findley loan rate, \$1.65; annualized volatility, 0.15 (low) and 0.25 (high); starting prices (representing the forward price for harvest at time of sign-up), \$2.15, \$2.45, \$2.75 and \$3.05 and risk free interest rate, 6%.

Results

The Monte Carlo algorithm was validated by computing the values of several European puts and calls and comparing them with those computed using the Black's analytical formula. There was virtually no difference in their values. With the introduction of path dependent payoffs, the results were as would be expected theoretically (Kemna and Vorst); i.e., Asian Puts <= European puts <= American Puts. Estimated standard errors were extremely low, ranging from 0.07 cents to 0.6 cents. Because of the low standard errors, variance reduction techniques such as the control variate method were not employed.

Valuation estimates for the deficiency and Findley components of the support programs for corn under different starting prices and annualized volatilities are summarized in Table 1. Neither set aside restrictions nor payment limits are imposed here. As expected, deficiency payments constitute the bulk of the value of the program payments. The value of the Findley payments is close to zero. Note that, unlike a standard option, the value of the deficiency payments decreases as volatility increases when the option is deep in the money. This reflects the lower-bound effect of the basic loan rate. Since Findley payments are possible at the extreme lower end of the distribution the value of the program payments which include Findley payments do increase with increasing volatility.

The values of program payments are compared to analogous exchange options in Table 2. The exchange puts are more valuable than the program payments by 2-3 cents per bushel under low volatility, and 4-5 cents under high volatility. The exchange puts are more valuable than the program payments for three reasons. First, the exercise feature of the exchange option is American while it is European for the program payments. Second, payoffs in the case of program payments are path dependent and thus imply a relatively lower variance. Third, the payoff region in the probability space covered by the exchange option is larger than that covered by the program payments because of the basic and Findley loan rates.

The value of program payments can be viewed in three alternative contexts. First, if it is believed that the hedging arguments underlying traditional option valuation theory hold for the "program payments option" then the value can be viewed as an equilibrium premium. However, the diversification process required under this theory is not possible in this context, particularly for the option buyer (farmer). Given the resulting risk facing the farmer, another context is where the estimated value is the value perceived by a risk-neutral farmer. If risk-averse, the farmer would not be willing to pay as much as the estimated value, implying that the estimated program payment "premium" overestimates the farmer's perceived value of the program. A third context involves the government's (option writer) perspective. By construction, the value of program payments is an estimate of the expected cost (outlay) of the program. Consequently, the exchange option premium can be compared directly to the program payments premium to estimate the expected difference in government outlays of implementing the program through traditional means versus using exchange options through the Option Pilot Program.

Given the different interpretation of the program payment values, the comparisons between the values of program payments and exchange puts in Table 2 indicate that: 1) the expected cost to the government of implementing the deficiency and Findley programs with exchange options is higher than the cost under traditional implementation and 2) from the perspective of a risk-averse farmer, the exchange put is greater in value than the put implicit in program payments by <u>at least</u> the amount shown in Table 2. Consequently, these results indicate that the 15 cents per bushel incentive payment in 1993 to participate in the OPP and the 5 cent payment in 1994 may not be needed to induce high participation in the pilot program, although there certainly may be learning costs which are not represented by the present analysis.

The effect of introducing payment limits was also investigated. The value of the program payments was computed for a range of base acres from 100-1000 acres, holding yield constant. The effect of payment limits is illustrated in Table 3. The value of the program payments is constant as the size of the farm (in terms of base acres) increases until the farm size is about 500 acres after which it falls with successive increases in farm size. Given that the yield levels represent central Illinois, this minimum of 500 acres presumably holds across most of the country.

A sample distribution of corn base acres by operator for two counties in central Illinois (Macon and Livingston) is presented in Table 4. This distribution reflects 351 sample farms obtained from the University of Illinois Farm Business Farm Management Association (FBFM) records. It is suspected that the farms in this sample are larger on average than farms in the state and the country. Still, 98.5 % of the base acres are below the level where payment limits are effective. In other words, base acres seem to be organized in such a manner that payment limits are essentially ineffective.

A final exercise involved the introduction of a 10% set aside requirement into the model. Net returns from soybeans (based on FBFM averages) were used to represent the opportunity cost associated with participating in the support programs. These results are summarized in Table 5. A 10% ARP reduces the value of the program payments by about 11 cents.

Conclusions

This study presented a general approach to valuing U.S. agricultural subsidies by explicitly recognizing the nature of the programs' contingent claims. The application focussed on comparing the Option Pilot Program (OPP) where an exchange traded put option is substituted for the deficiency and Findley programs.

Empirical results indicate that the "exotic" option features of the farm programs cause their value to be less than comparable exchange traded puts, indicating that the expected cost to the government under the OPP is greater than expected cost of the traditional programs. It was also shown that while farm size is an important determinant of the theoretical valuation of government subsidies, it may be merely an academic issue in light of the distribution of base acres. Further work on the empirical valuation of the loan rate program is ongoing.

Table 1. "Value" of Deficiency and Findley Programs

	Starting Price			
	$ 2.15	$ 2.45	$ 2.75	$ 3.05
a) Low Volatility				
Deficiency Payments	0.547	0.308	0.127	0.038
Advance Payments	0.014	0.007	-	-
Findley Payments	0.009	0.009	-	-
Program Payments	0.570	0.324	0.127	0.038
b) High Volatility				
Deficiency Payments	0.525	0.350	0.206	0.108
Advance Payments	0.014	0.007	-	-
Findley Payments	0.039	0.014	0.005	0.002
Program Payments	0.578	0.372	0.211	0.110

Table 2. "Value" of Program Payments and Comparable American Put

	Starting Price			
	$ 2.15	$ 2.45	$ 2.75	$ 3.05
a) Low Volatility				
Program Payments	0.570	0.316	0.127	0.038
American Put	0.600	0.337	0.158	0.060
Difference	-0.030	-0.021	-0.031	-0.022
b) High Volatility				
Program Payments	0.578	0.372	0.211	0.110
American Put	0.632	0.419	0.263	0.156
Difference	-0.054	-0.047	-0.052	-0.046

Table 3. Effect of Payment Limits on the "Value" of Program Payments[5]

	Starting Price			
Base Acres	$ 2.15	$ 2.45	$ 2.75	$ 3.05
Low Volatility				
100	0.570	0.324	0.127	0.038
250	0.570	0.324	0.127	0.038
350	0.570	0.324	0.127	0.038
500	0.553	0.322	0.127	0.038
750	0.442	0.290	0.122	0.037
1000	0.354	0.250	0.111	0.035
High Volatility				
100	0.578	0.372	0.211	0.110
250	0.578	0.372	0.211	0.110
350	0.578	0.372	0.211	0.110
500	0.551	0.360	0.206	0.108
750	0.430	0.296	0.177	0.097
1000	0.350	0.245	0.151	0.084

Table 4. Sample Distribution of Corn Base and Total Cultivated Acres in Central Illinois (Acres/Operator)

Acres	Corn Base Acres		Total Cultivated Acres	
	Frequency	Percent	Frequency	Percent
0 - 200	272	79.3	125	36.8
200 - 300	53	15.5	85	24.7
300 - 400	13	3.8	61	17.7
400 - 600	5	1.5	61	17.7
600 - 900	-	-	10	2.8
> 900	-	-	1	0.3
Total	343	100.0	343	100.0
Mean	129.6		575.6	

[5]Set aside requirement set at 0%.

Table 5. Effect of a 10% ARP Requirement

	Starting Price			
	$ 2.15	$ 2.45	$ 2.75	$ 3.05
a) Low Volatility				
Program Payments				
- without ARP	0.570	0.316	0.127	0.038
- with 10% ARP	0.457	0.204	0.015	-0.075
b) High Volatility				
Program Payments				
- without ARP	0.578	0.372	0.211	0.110
- with 10% ARP	0.465	0.259	0.098	-0.003

References

Barone-Adesi, G. and R.E. Whaley. "Efficient Analytic Approximation of American Option Values." *The Journal of Finance* 42 (1987): 301-20.

Boyle, P.P. "Options: A Monte Carlo Approach." *Journal of Financial Economics* 4 (1977): 323-38.

Cox, J.C. and S.A. Ross. "A Survey of Some New Results in Financial Option Pricing." *The Journal of Finance* 31 (1976): 383-402.

Cox, J.C., S.A. Ross and M. Rubinstein. "Option Pricing: A Simplified Approach." *Journal of Financial Economics* 3 (1979): 229-63.

Gardner, B.L. "Structuring Incentives for change in U.S. Farm Programs." *American Journal of Agricultural Economics* 67 (1985): 336-40.

Gemmil, G. "The Contribution of Futures and Options Markets to a Revised Agricultural Policy." *European Review of Agricultural Economics* 15 (1989): 457-75.

Hauser, R.J. "Discussion - Policies that Operate Through or Increase Farmers' Awareness and Potential Use of Futures, Options, and Cash Forward Markets." *Symposium Proceedings - Options, Futures and Agricultural Commodity Programs* (1988): 45-54.

Heifner, R.G. and T.L. Sporleder "Alternative Public programs to Increase Farmers' Awareness and potential Use of Forward Markets." *Symposium Proceedings - Options, Futures and Agricultural Commodity Programs* (1988): 34-44.

Hull, J.C. Options, Futures and other Derivative Securities. Second Edition, Englewood Cliffs, New Jersey, Prentice-Hall Inc., 1993.

Hull, J.C. and A. White. "The Pricing of Options on Assets with Stochastic Volatilities." *The Journal of Finance* 42 (1987): 281-300.

Kahl, K.H. "Agricultural Options: An Alternative to Current Agricultural Programs." *Agribusiness* 2 (1986): 215-24.

Kang, T. and B.W. Brorsen. "Valuing Target Price Support Programs With GARCH Average Option Pricing." Unpublished manuscript, (1993): 23 pages.

Kemna, A.G.Z. and A.C.F. Vorst "A Pricing Method for Options Based on Average Asset Values." *Journal of Banking and Finance* 14 (1990): 113-29.

Marcus, A.J. and D.M. Modest. "Futures Markets and Production Decisions" *Journal of Political Economy* 92 (1984): 409-26.

Marcus, A.J. and D.M. Modest. "The Valuation of a Random Number of Put Options: An Application to Agricultural Price Supports." *Journal of Financial and Quantitative Analysis* 21 (1986): 73-86.

Merton, R.M. "On the Pricing of Contingent Claims and the Modigliani-Miller Theorem." *Journal of Financial Economics*, 5 (1977): 241-249.

Petzel, T. "Toward a Market Orientation: The Dilemma Facing Farm Policy in the 1980s." in U.S. Agricultural Policy: The 1985 Farm Legislation, edited by B. Gardner, American Enterprise Institute, Washington D.C. (1985): 350-354.

Randall, A.J. "Commentary" in U.S. Agricultural Policy: The 1985 Farm Legislation, edited by B. Gardner, American Enterprise Institute, Washington D.C. (1985): 378-81.

Schertz, L.P. "Agricultural Options or Price Supports: Competitive or Compatible?" *Agricultural Economics Research* 37 (1985): 27-29.

Sherrick, B.J. "A Simple Valuation Model for Loan Guarantees and a Comparison of a State and Federal Program", Unpublished manuscript, (1992): 22 pages.

Sosin, H.B. "On the Valuation of Federal Loan Guarantees to Corporation." *Journal of Finance*, 35 (1980): 1209-21.

Turvey, C.G. "Contingent Claim Pricing Models Implied by Agricultural Stabilization and Insurance Policies." *Canadian Journal of Agricultural Economics* 40 (1992): 183-98.