Farmland Control Decisions under

Different Intertemporal Risk Behavioral Constructs

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Date of Publication: May 10,2005

Selected Paper, 2005 Annual Meetings of

the American Agricultural Economics Association, Providence, RI, July 24-27, 2005.

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Please note that the study reported in this manuscript is a work-in-progress and that only preliminary results have been reported.

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Abstract:

Simulation-optimization techniques are employed to analyze changes in farmland control arrangements as a result of using different constructs of intertemporal risk behavior. Risk behavior based on constant absolute risk aversion (CARA) and constant relative risk aversion (CRRA) mean-standard deviation functions are used to achieve this objective. Specfically, a multi-period programming framework for a representative grain farm is developed to explore farmland control decisions under these two behavioral assumptions. Our results suggest that the use of a CRRA behavioral construct in analyzing farmland control decisions produce predictions that are more consistent with observed farm behavior.

Keywords: cash leasing, constant absolute risk aversion, constant relative risk aversion, decreasing absolute risk aversion, increasing relative risk aversion, share leasing, simulation, optimization

JEL Codes: Q100, Q140, Q150

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Farmland leasing, either through payment of pre-determined cash rents or sharing of production revenues and certain production costs (between landlords and farm operator-tenants), has become an increasingly popular alternative for gaining additional farm acreage outside the land purchase option. For example, the USDA's 1998 Agricultural Resource Management Survey (ARMS) study indicates that 43.8% of farmland acres in the United States are operated under a leasing contract. Leasing is even a more dominant practice in Midwestern United States. In Illinois, for instance, 78% to 86% of tillable farmland is either cash- or share-rented, a trend maintained over the period 1995-2001 according to a 2002 survey (Barry, Sotomayor, and Moss). In the late eighties, the average tenure ratio (proportion of land owned to total acreage operated) for participating farms under the Illinois Farm Business Farm Management (FBFM) was 24% (Ellinger, *et al*.)

A farm operator usually expands the area of controlled farmland for farm operations through one of the two leasing arrangements, through debt-financed land ownership, or a combination of any of these three methods. Farmland control decisions are usually based on the different risk-return tradeoffs realized under the three alternative control methods. Share leasing is considered the most highly risk efficient financing option for farmers (Barry, *et al.*). The positive correlation between the value of harvested crops and the tenant farmer’s rental obligation to the landowner stabilizes the farmer’s net income, thus resulting in greater risk-reducing benefits for the farm operator. Cash leasing, on the other hand, offers farmers simpler, more flexible bidding opportunities for greater farmland control, though the farmer ends up assuming all production and income risks (Barry, Sotomayor and Moss).

The risk-return tradeoffs of the farmland control decision problem can be evaluated using an expected utility mean-variance (EUMV) framework, an analytical tool widely used in economics and finance to analyze how people make choices among risky alternative actions. Meyer developed a generalized EUMV framework based on the location-scale parameter condition that ensures the equivalence of preference ordering under expected utility and mean-variance frameworks. Meyer's work generalized the EUMV approach to resolve restrictive conditions previously imposed on utility functions and distribution properties of the random variable. These restrictive conditions have limited previous risk analyses to EUMV formulation exhibiting a specific risk behavioral construct, i.e. constant absolute and increasing relative risk aversion (CARA-IRRA). Nelson and Escalante utilized Meyer's general economic decision model to develop an alternative to the CARA-IRRA framework that adopts the more empirically supported behavior of decreasing absolute and constant relative risk aversion (DARA-CRRA).

This study considers the CARA-IRRA and DARA-CRRA models to determine trends in farmland control decisions that can be influenced by changes in intertemporal risk behavior. A multi-period programming framework using optimization-simulation techniques applied to a representative grain farm is used to accomplish this objective. The mathematical programs are developed by separately using the decision problem statement functions for the CARA-IRRA and DARA-CRRA models. The analytical framework is then expanded to accommodate sensitivity analyses involving gradual increases in the magnitude of the risk variable to determine changes in the optimal farmland control solutions. The following sections discuss the theoretical model in greater detail, explain the simulation-optimization analytical approach, and then present this study's results and their implications.

Theoretical/Conceptual Foundations

Background

An expected utility-mean variance (EUMV) framework will be used to analyze patterns of choices among available farmland control strategies by considering these options' risk-return tradeoff profiles and the underlying intertemporal risk attitudes of farm operators. The traditional form of the unconstrained EUMV decision model used in the analyses of farm finance, marketing, and production issues has been:

$$E(U(W)) = \mu - 0.5\rho\sigma^2 \quad (1)$$

where $E(U(W))$ is the expected utility of final wealth, μ is the expected (or the mean) final wealth, σ^2 is the variance of final wealth and ρ is the coefficient of absolute risk aversion.

Consistent with Freund's results, this model is formulated as a static mean variance representation of an expected utility maximization problem with normally distributed returns and a risk behavior exhibiting constant absolute and increasing relative risk aversion (CARA-IRRA). The model produces intuitively reasonable solutions and behavioral predictions, with an important exception about its prediction on responses to changes in initial wealth, predicting that optimal debt levels will decrease if initial wealth increases. This is a result of the underlying behavioral assumption of CARA-IRRA, which implies that investments in a risky asset are a constant function of wealth.

An alternative formulation of the model has been developed that replaces the CARA assumption with the decreasing absolute risk aversion (DARA) and constant relative risk aversion (CRRA) behavioral hypotheses (Nelson and Escalante). The alternative form of the objective function is:

$$V(\sigma,\mu) = -(\mu^2 - \gamma\sigma^2)^{-1} \quad (2)$$

where the only modification from the original formulation, except for the new functional form, is the redefinition of the risk aversion parameter γ as a scaled coefficient of relative risk aversion. The new model retains the desirable comparative static properties of the existing CARA model while correcting the questionable negative initial equity effect by using the more desirable DARA-CRRA behavioral hypotheses.

Empirical and Theoretical Arguments for DARA-CRRA

On both theoretical and empirical planes, decreasing absolute risk aversion enjoys greater support than constant absolute risk aversion behavioral construct. The intuitive appeal of the DARA behavior was presented in the original works of Arrow and Pratt, who introduced these intertemporal risk behavioral concepts. Since then, DARA behavior has been regarded as the normative concept. Pratt argues that decision-makers would tend to "pay less for insurance against a given risk the greater their assets (p. 123)" while Arrow contends that a decision maker faced with increasing wealth would find it absurd to be more unwilling to take a fair bet involving a fixed amount.

In agriculture and other applied areas of economics, DARA behavior has gained stronger empirical support than alternatives. Studies conducted by Saha, Shumay, and Talpaz, and Chavas and Holt provide evidence for the DARA behavior among farmers. The econometric analyses employed by other studies also indicate that measures of risk aversion vary inversely with land under control, off-farm income (Moscardi and de Janvry, Young, et al), and net worth (Patrick, Whitaker and Blake), thus, lending more support to DARA behavior.

The original derivation of the CARA-IRRA model used results of Freund to justify the mean-variance functional form. This justification carries with it the implicit assumptions of constant absolute risk aversion and normal returns. Constant absolute risk aversion might be an acceptable behavioral hypothesis for a small class of decision-makers who have common wealth levels. In this case, it would serve as an approximation. But anytime the model is applied to decision-makers with significant differences in initial wealth, the constant absolute risk aversion behavioral construct should be replaced by decreasing absolute risk aversion. Differences in initial wealth should cause significant differences in the willingness of decision-makers to undertake risky investments of a given size. Frequently, decreasing absolute risk aversion is introduced by assuming constant relative risk aversion. The implication of decreasing absolute risk aversion is the behavioral hypothesis of constant relative risk aversion.

Another reason why the behavioral hypothesis of constant relative risk aversion is desirable is that such functions exhibit risk vulnerability. The idea of risk vulnerability is: "... that adding an unfair background risk to wealth makes risk-averse individuals behave in a more risk-averse way with respect to another independent risk." (Gollier and Pratt, p.1110) An unfair risk is a risk with a non-positive expected value. One important implication of risk vulnerability is that opening new insurance or contingent claim markets should stimulate economic activity in other risky markets. Risk vulnerability is a desirable behavioral hypothesis. And utility functions with the property that absolute risk aversion is decreasing and convex are risk vulnerable (Gollier and Pratt, p.1117). Thus, constant relative risk aversion utility functions have the desirable properties of risk vulnerability, and decreasing absolute risk aversion.

Programming Applications on a Representative Grain Farm

A numerical optimization analysis of a representative grain farm using both the CRRA mean-standard deviation function and the CARA mean-standard deviation function is employed to illustrate different responses of key farmland control decision variables to a change in the farmer's intertemporal risk behavior. The analysis is also extended to determine the sensitivity of such decision variables to changes in the decision-maker's risk aversion level as well as increases in business and financial risk magnitudes.

Base Financial Conditions

A representative farm is created using average resource endowments, operating levels and financial conditions of about 1,004 grain farms in the North Central Region that participate under Illinois' Farm Business Farm Management (FBFM) Program. This farm, managed by a 49 year-old farmer belonging to a family of three, produces corn and soybeans in a 50/50 rotation, operates a total of 862 tillable acres of farmland, of which 250 are owned and the remainder covered by leasing contract(s).

The fair market value of the farm's assets is $1.02 million at the start of the programming horizon, including $209,253 worth of farm equipment, farm land property valued at $480,308, building improvements worth $105,536, and current assets of $224,862. These assets were financed by 87% debt and 13% farm equity. The family's annual withdrawals from equity for family living expenses amount to $31,729, excluding income taxes.

Using the financial and structural attributes of the representative farm as a starting point, this analysis assumes a two-year planning horizon and considers final wealth as the outcome variable that is determined by the value of farmland, farm equipment and ending cash balance, net of deductions for outstanding loan balances, at the end of the planning horizon. This analytical framework is based on previous multi-period programming models developed by Barry and Willmann, and Gwinn, Barry and Ellinger. A large matrix of activities and constraints is developed where sub-matrices along the main diagonal elements correspond to time periods and off-diagonal elements represent transfers among the model's activities. The representative farm in this analysis is assumed to engage in production and marketing, land and machinery investments, share and cash renting of farmland, liquidity management, consumption, taxation and incurring short-, intermediate- and long-term loans. Financing and operating decisions are constrained by limits set on land availability, machinery requirements, consumption, and borrowing levels. Specifically, borrowing decisions are constrained by the level of the unused portion of the farm's credit reserves, which is the amount that lenders are still willing to lend to the farm given existing financial obligations and operating conditions. The level of credit reserves are calculated from liquidity changes in the balance sheet, expected income, changes in outstanding loan levels, and changes in asset values (Gwinn, Barry and Ellinger 1992). Credit decisions are also matched with the type of asset acquisition decisions. Specifically, long-, medium- (or intermediate-) and short-term loans can supplement internally generated funds intended to be used for the acquisition of farm real estate (or fixed assets), farm equipment (or other intermediate assets), and operating capital requirements, respectively.

Timing and Liquidity Issues

In order to capture the timing of cash flows within a particular year, the cash transfer equation has two sub-periods. This feature of the programming model allows us to capture timing and liquidity issues that may determine preferences of the leasing parties for share versus cash lease contracts. Under share leases the landlord is obligated for his share of variable costs when payment is due. Under cash leasing, the farmer often must pay all or part of the annual rent in advance and bear all of the operating expenses, thus placing greater demands on his cash flow. Additionally, the landlord may require higher per acre cash rents for late or split payments (e.g. half paid during spring, the other half in fall) to compensate for her time value of money.

In the programming model, the landlord is assumed to advance (during the first transfer period) half of the shared operating costs under a share lease contract. Cash rents are paid in two equal installments during the production year. Down payment for land purchases are paid as transactions are completed, while loan amortizations for credit incurred to purchase land are regularly paid on an annual basis, in accordance with a specified loan amortization schedule.

The Variance-Covariance Matrix

Historical data on the decision variables of the model are used to construct a variance-covariance matrix that accounts for the sources of risk in the model. The decision variables in this model represent purchases of additional farmland (ACBUY) and farm machinery (EQBUY), share (SHLEASE) and/or cash renting (ACRENT) of supplemental farmland acreage, and incremental loans incurred under short- (SHTCRED), intermediate- (MEDCRED) and long-term (FINLAND) credit facilities. Specifically, the sources of risk are defined as follows. The variability of gross crop margins (ACPROD) captures the combined effects of the variability of crop yields and prices over a long period of time. Unanticipated changes in asset values are accounted for by considering the variability of land (ACBUY) and equipment (EQBUY) values. Changes in gross margins resulting from payment of cash rental rates (ACRENT) are included to provide additional source of variability not captured by the land value component of the matrix. The effective risk reduction mechanism inherent in share leasing contracts (Barry, *et al.*) is introduced by recalculating reduced levels of gross margins (SHLEASE) according to the sharing arrangement assumed in the model. Finally, the volatility of borrowing costs for short-term operating loans (SHTCRED), intermediate term loans for equipment purchases (MEDCRED) and long-term real estate loans (FINLAND) is considered to capture the financial risk component of the model.

This analysis used fourteen years of historical data (1985-1998) obtained from the Agricultural Finance Data Book published by the U. S. Department of Agriculture and from the

Illinois Agricultural Statistics Service web site. The signs of the entries in the matrix, except for covariance terms among asset/income-generating activities and among liabilities/cost-generating activities, were adjusted to correctly specify directional effects of certain pairs of activities on risk reduction. Specifically, this adjustment ensures that lower correlations are more preferred among assets (and among liabilities) which potentially reduce aggregate risk in the model. Moreover, higher correlations between assets and liabilities were assigned the opposite of their estimated signs to account for the reversal of the preferred correlation relationship between these activities.

Levels of Risk and Risk Aversion

Initial runs assumed a base risk level determined by the historical values for the decision variables that were used to develop the variance-covariance matrix. Sensitivity to increases in risk was analyzed by considering four additional scenarios where the variance-covariance matrix was multiplied by scalars 1.5, 2.0, 2.5, and 3.0.

Several levels of risk aversion were considered for both the CARA-IRRA and DARA-CRRA models. The CRRA model, which adopts the coefficient of relative risk aversion as a representation of risk attitudes, used risk aversion levels falling within the bounds [0.27, 4.95], calculated by Nelson and Escalante using mean historical financial attributes of Illinois farms. The CARA model's risk aversion parameter values, which correspond to the coefficient of absolute risk aversion, are within the range [0.000004, 0.346574], established by Babcock, Choi, and Feinerman in their study of risk and probability premiums for CARA utility functions (Babock, Choi and Feinerman 1993). Both of these sets of bounds appear to be reasonable limits, given the plausible programming solution levels obtained in the analysis.

Results and Discussion

Table 1 summarizes the programming results under the two risk behavioral constructs and under different levels of risk aversion. The CARA-IRRA model used absolute risk aversion levels ranging from 0.000004 to 0.00012 while the risk aversion values in the DARA-CRRA model ranged from 0.27 to 1.90. The low and high endpoints of these two ranges were paired to correspond to lower and higher risk aversion conditions, respectively. The values 0.00008 and 0.90 were chosen to represent “moderate” risk aversion conditions for the CARA-IRRA and DARA-CRRA models, respectively.

Under the CARA-IRRA model, increases in the levels of absolute risk aversion resulted in substantial downsizing of farm operations. Optimal farm size is substantially reduced from 851 acres under the lowest risk aversion level to only 323 acres for the most risk-averse farmer, representing a downsizing rate of 62.04%. Other farm size adjustments in the CARA-IRRA model include a reduction of 352 acres (or a downsizing rate of 41.36%) from the low to moderate risk aversion categories and 176 acres (or a reduction rate of 35.27%) as risk aversion shifted from moderate to high levels.

Results under the CRRA model indicate less downsizing -- from 906 acres using the lower bound value of the risk aversion parameter to 407 acres for the upper bound value. This only amounts to a 55.08% reduction rate. The shift from low to moderate risk aversion produced a downsizing rate of 41.50% (which is comparable to the result obtained in the CARA-IRRA model above) but the change from moderate to high risk aversion only resulted in a reduction of 123 acres or a rate of 23.08%.

The adjustment rates in the optimal debt solutions across different levels of risk aversion are not consistent with the farm size reduction rates under the two models. The CARA-IRRA debt solutions decreased at a much slower rate relative to changes in the total asset size, thus resulting in increasing debt-to-asset ratios as risk aversion increased. Reduction rates in DARA-CRRA optimal debt solution levels, on the other hand, were large enough relative to the total asset size reductions, thus, resulting in debt-to-asset ratio solutions that were decreasing as risk aversion levels were increased.

The optimal leasing solution levels provide interesting implications when analyzed along with the farm downsizing trends observed in both models. Given the risk aversion parameter values for low and moderate risk aversion, the proportion of share leased acres to farm size increased from 0.6691 to 0.7198 in the DARA-CRRA model. In the same model and transitioning from low to moderate risk aversion, the proportion of cash leased acres to farm size decreased from 0.1268 to 0. The same (decreasing) trend in cash leasing ratios is noted in the CARA-IRRA programming results. However, the CARA-IRRA model produced decreasing share leasing ratios (from 0.0900 to 0.0416) as risk aversion categories shift from low to moderate levels (as compared to the increasing share leasing ratio under DARA-CRRA).

These trends in share and cash leasing ratio solutions are plotted in Figure 1 for the three levels of risk aversion. The plots indicate that the trends observed in the transition from low to moderate risk aversion were reversed for both (cash and share) leasing ratios under the DARA-CRRA model and for the share leasing ratio in the CARA-IRRA model. Only the cash leasing ratio under the CARA-IRRA model displayed monotonically decreasing solution values.

Tables 2 to 4 summarize the results under increasing risk conditions. Each table correspond to a risk aversion category (low, moderate, and high) and presents results on the optimal programming solution levels for the same set of variables listed in Table 1 under conditions of increasing risk. The initial base risk (given by the calculated variance-covariance matrix) used in deriving solutions reported in Table 1 has been increased 4 times through scalar multiplication of the matrix. As mentioned in the previous section, the scalar multiplier values used were 1.5, 2.0, 2.5, and 3.0.

Across all levels of risk aversion (Tables 2 to 4), increases in the magnitude of the risk variable resulted in shrinkages in farm size solution levels. In the low and moderate risk aversion categories (Tables 2 and 3), the CARA-IRRA model consistently produced more significant downsizing trends than the DARA-CRRA model. In Table 2, for instance, the optimal farm size levels decreased at an average rate of 21.35% for every 50% increase in risk in the CARA-IRRA model, while the equivalent rate for the DARA-CRRA model is only 11.83%. In absolute terms, the CARA-IRRA farm size solutions started at 686 acres when risk increased 1.5 times and ended up at 323 acres when the risk level was tripled. In the DARA-CRRA model, the optimal farm size started at 890 acres when risk was 1.5 times larger than the base level and became 541 acres when the base risk level tripled.

The low risk aversion category produced clearer trends in the optimal solution levels for the leasing variables. These trends can be deduced from the plots presented in Figure 2. The DARA-CRRA model yielded share leasing ratio solutions following a U-curve trend across increasing risk levels. This means that share leasing ratios tended to decrease slightly as relatively smaller increases in risk are experienced. The initial downward trend in the share leasing ratios, however, reaches a minimum when the risk matrix was multiplied by 2. As further increases in risk were assumed, a much steeper increasing trend in the ratios was observed.The cash leasing ratio solutions for the DARA-CRRA model, on the other hand, follow an inverted U trend. The peak is also recorded at the point when risk was doubled. The CARA-IRRA solutions obtained displayed the same trends as those noted in the DARA-CRRA solutions. The minimum share leasing ratio and maximum cash leasing ratio were recorded at the point when risk increased 1.5 times.

In both Figures 1 and 2 and across all tables (1 to 4), it can be observed that the CARA-IRRA model tend to produce higher cash leasing and lower share leasing solution ratios. Share leasing, on the other hand, is a more dominant form of farmland control arrangement in the DARA-CRRA model. In Figures 1 and 2, for instance, the DARA-CRRA share rented ratio and CARA-IRRA cash rented plots are always above the other two plots.

Summary and Conclusions

This study utilized multi-period programming techniques to analyze the effects of changes in the intertemporal risk behavioral assumptions on farmland control decision variables. Decision problem statements reflecting the risk behavioral assumptions of CARA-IRRA and DARA-CRRA were used in the programming framework. Iterations of the programming model were introduced to capture changes in farmland control decisions as a result of changes in the decision maker's risk attitudes and increases in the magnitude of risk.

The results indicate that both the CARA-IRRA and DARA-CRRA models produced optimal farm size solutions that monotonically decrease as farmers' risk aversion increases. Farm downsizing, however, has been more significant in the CARA-IRRA model. Increases in risk aversion from low to moderate levels also produced greater reliance on share leasing as a form of farmland control arrangement in the DARA-CRRA framework. A contrasting (declining) trend in share leasing ratios was observed in the CARA-IRRA framework, which favors cash leasing over the share leasing option.

Increases in the risks faced by the farmer also resulted in farm downsizing and the CARA-IRRA model again produced optimal farm size solutions that substantially declined as the risk magnitude was increased (as compared to the lower decline observed in the DARA-CRRA model). In the DARA-CRRA model, farmers tend to rely more on share leasing when the original base risk level is at least doubled. In the CARA-IRRA model, farmers start to be increasingly dependent on share leasing when the base risk level is only increased 1.5 times.

The DARA-CRRA solutions consistently indicate greater dependence on share leasing as share leasing ratios obtained were significant larger than the DARA-CRRA cash leasing ratio solutions and the CARA-IRRA share leasing ratio solutions. On the other hand, the CARA-IRRA solutions produced comparably high cash leasing ratio solutions.

Based on these preliminary results, the DARA-CRRA model tends to produce more plausible farmland control solutions that emphasize the greater relevance of share leasing as farmers become increasingly risk averse and under worsening farm business and financial risk conditions. In addition, our preliminary results show that very different inference about farmland control decisions may arise when the DARA-CRRA behavioral assumption is used in the analysis rather than the more traditionally used CARA-IRRA behavioral specification.

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Table 1. Programming solutions under the CARA-IRRA and DARA-CRRA models at different levels of risk aversion

Variables	CARA-IRRA Model			DARA-CRRA Model		
	0.000004	0.00008	0.00012	0.27	0.90	1.90
Farm Size (acres)	851	499	323	906	530	407
Total Assets ($'000)	972	934	915	843	838	839
Total Debt ($'000)	381	368	363	382	370	365
Acres Cash Rented	602	294	80	115	0	54
Acres Share Rented	77	21	66	606	380	203
Cash Rented-Farm Size Ratio	0.7073	0.5896	0.2485	0.1268	0.0000	0.1329
Share Rented-Farm Size Ratio	0.0900	0.0416	0.2031	0.6691	0.7168	0.4988
Share Rented – Rented Acres Ratio	0.1134	0.0667	0.4521	0.8405	1.0000	0.7899
Debt-Asset Ratio	0.3915	0.3946	0.3966	0.4536	0.4421	0.4358

Table 2. Programming solutions under the CARA-IRRA and DARA-CRRA models under increasing risk levels, LOW RISK AVERSION

Variables	CARA-IRRA Model (risk aversion coefficient at 0.000004)				DARA-CRRA Model (risk aversion coefficient at 0.27)			
	1.50 x	2.00 x	2.50 x	3.00 x	1.50 x	2.00 x	2.50 x	3.00 x
Farm Size (acres)	686	499	378	323	890	793	628	541
Total Assets ($'000)	954	934	920	915	842	841	839	838
Total Debt ($'000)	375	368	365	363	382	378	373	371
Acres Cash Rented	509	294	142	80	168	198	53	0
Acres Share Rented	0	21	57	66	572	445	425	391
Cash Rented-Farm Size Ratio	0.7419	0.5896	0.3742	0.2485	0.1888	0.2499	0.0847	0.0000
Share Rented-Farm Size Ratio	0.0000	0.0416	0.1515	0.2031	0.6426	0.5610	0.6765	0.7228
Share Rented – Rented Acres Ratio	0.0000	0.0667	0.2864	0.4521	0.7730	0.6921	0.8891	1.0000
Debt-Asset Ratio	0.3928	0.3946	0.3965	0.3966	0.4531	0.4496	0.4450	0.4424

Table 3. Programming solutions under the CARA-IRRA and DARA-CRRA models under increasing risk levels, MODERATE RISK AVERSION

Variables	CARA-IRRA Model (risk aversion coefficient at 0.00008)				DARA-CRRA Model (risk aversion coefficient at 0.90)			
	1.50 x	2.00 x	2.50 x	3.00 x	1.50 x	2.00 x	2.50 x	3.00 x
Farm Size (acres)	323	297	282	271	472	422	369	337
Total Assets ($'000)	915	910	908	906	837	838	840	840
Total Debt ($'000)	363	362	362	361	368	366	364	362
Acres Cash Rented	80	92	102	104	0	39	94	128
Acres Share Rented	66	34	14	4	322	233	125	59
Cash Rented-Farm Size Ratio	0.2485	0.3108	0.3623	0.3851	0.0000	0.0924	0.2551	0.3796
Share Rented-Farm Size Ratio	0.2031	0.1134	0.0493	0.0156	0.6822	0.5522	0.3380	0.1749
Share Rented – Rented Acres Ratio	0.4521	0.2698	0.1207	0.0370	1.0000	0.8566	0.5708	0.3155
Debt-Asset Ratio	0.3966	0.3974	0.3980	0.3983	0.4397	0.4367	0.4333	0.4313

Table 4. Programming solutions under the CARA-IRRA and DARA-CRRA models under increasing risk levels, HIGH RISK AVERSION

Variables	CARA-IRRA Model (risk aversion coefficient at 0.00012)				DARA-CRRA Model (risk aversion coefficient at 1.90)			
	1.50 x	2.00 x	2.50 x	3.00 x	1.50 x	2.00 x	2.50 x	3.00 x
Farm Size (acres)	288	271	265	263	329	291	274	274
Total Assets ($'000)	909	906	905	904	840	841	842	842
Total Debt ($'000)	361	361	361	361	362	361	360	360
Acres Cash Rented	98	104	106	108	136	141	124	124
Acres Share Rented	23	4	0	0	42	0	0	0
Cash Rented-Farm Size Ratio	0.3391	0.3851	0.4025	0.4106	0.4146	0.4854	0.4516	0.4516
Share Rented-Farm Size Ratio	0.0783	0.0156	0.0000	0.0000	0.1291	0.0000	0.0000	0.0000
Share Rented – Rented Acres Ratio	0.1876	0.0390	0.0000	0.0000	0.2374	0.0000	0.0000	0.0000
Debt-Asset Ratio	0.3977	0.3983	0.3986	0.3987	0.4308	0.4286	0.4278	0.4278

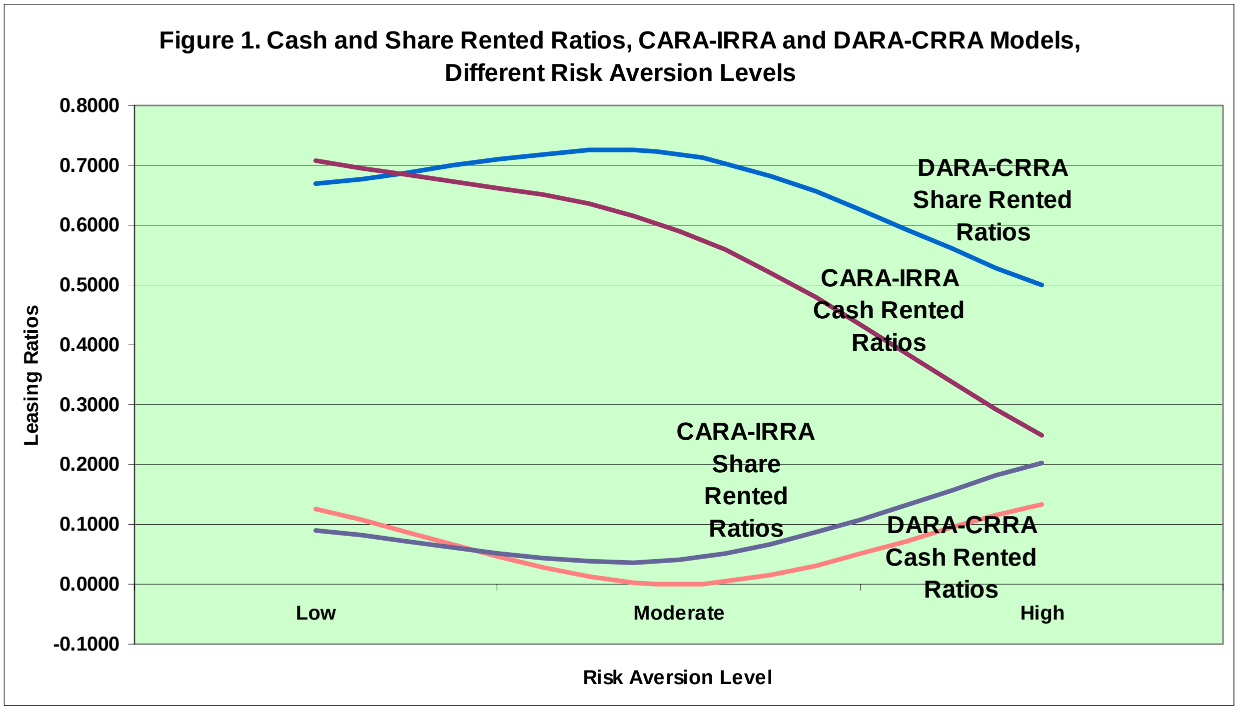
Figure 1. Cash and Share Rented Ratios, CARA-IRRA and DARA-CRRA Models, Different Risk Aversion Levels
0.8000
0.7000
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
-0.1000
Leasing Ratios
DARA-CRRA Share Rented Ratios
CARA-IRRA Cash Rented Ratios
CARA-IRRA Share Rented Ratios
DARA-CRRA Cash Rented Ratios
Low
Moderate
High
Risk Aversion Level

Figure 2. Cash and Share Rented Ratios, CARA-IRRA and DARA-CRRA Models, Changing Risk Levels