EFFECT OF DEBT POSITION ON THE CHOICE OF MARKETING STRATEGIES FOR FLORIDA ORANGE GROWERS: A RISK EFFICIENCY APPROACH

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Abstract

This study examined the relationship between debt position and choice of marketing instrument. Specifically, this study employed first and second degree stochastic dominance, and stochastic dominance with respect to a function to determine whether the efficient marketing instrument changes between debt positions. The results indicate that the choice of marketing instrument does vary with debt position in some marketing periods if the decision-maker is moderately risk averse.

Key words: debt position, marketing instruments, stochastic dominance

Recently agricultural economics literature has begun to examine the linkage between the producer's debt level and the optimum choice of marketing instrument. Moss and van Blokland indicated that the choice of marketing instrument may vary across debt positions for Florida orange producers. Similarly, Turvey and Baker have indicated that the choice of marketing instrument may be dependent on the choice of debt position for corn and soybean farmers. The results of both of these studies question the applicability of the separation theorem proposed by Tobin which states that the optimum choice of risky assets is independent from the decision on leverage.

The separation theorem derived from Tobin's work and advanced in the development of the Capital Asset Pricing Model by Sharpe, Lintner, and Mossin is dependent on a risk-free, or zero-beta, cost of capital in society. This assumption is valid when considering aggregate movements in the portfolio of hypothetical investors. However, the cost of capital to agriculture is neither fixed nor unsystematic. Specifically, Tweeten, Schuh, and Rausser et al. have argued that changes in the interest rate could have significant ramifications for agriculture in the United States through distortion of the return to agriculture in relation to other domestic investments.

Moss and van Blokland and Turvey and Baker attempted to demonstrate how the choice of optimal marketing strategy and optimal solvency ratio varies with stochastic interest rates. For example, net returns from marketing oranges using futures may be more highly correlated with interest rates than would be net returns using cash markets. If returns from a futures hedge are positively correlated with changes in the interest rate, a higher real interest rate would imply higher returns on hedging. Thus, the negative effect of higher leverage positions would be somewhat offset by increased returns. This implies that producers with higher leverage positions would prefer a hedging strategy over marketing strategies less positively correlated with interest rates, *ceterus paribus*. Thus, the debt position and the degree of correlation between the rate of returns under each marketing strategy must both be considered in determining the appropriate marketing strategy for an agricultural producer. If the optimal marketing strategy is affected by the producer's debt position, then past attempts to recommend marketing strategies based solely on the distribution of revenue may have yielded biased results.

This study examines the effect of debt position on the choice of marketing strategy for Florida orange producers given different debt positions and stochastic interest rates. Specifically, this study used stochastic dominance to determine which marketing instruments were dominant across debt levels. If the same marketing instruments were dominant across debt levels, then debt had little effect on the choice of marketing strategy.

The methodology used in this study departs from previous work in this area in two ways. First, the study assumes that the firm's level of debt is fixed. Thus, the firm cannot use the choice of debt to balance the risk of alternative marketing instruments as in the risk-balancing models presented in Gabriel

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and Baker and Collins. This is probably a more appropriate assumption for the citrus industry since most grove owners are unable to adjust debt levels at will. Second, this study used efficiency measures to compare the riskiness of alternative debt/marketing instrument scenarios. In contrast, previous work in this area has utilized expected utility models.

The following section provides a literature review on stochastic dominance, the risk efficiency technique used in this study. The methodology and data used in this study are then presented, followed by a description of the empirical results and resulting conclusions.

STOCHASTIC DOMINANCE

The theoretical basis for decision-making in a risky or uncertain world is the expected utility hypothesis. The expected utility hypothesis basically states that given complete and transitive preferences, economic agents choose the action that maximizes their expected economic well-being. This theoretical result is based on axiomatic postulates and has been generally accepted by all but a few detractors who primarily object to the strict transitivity of preferences (Fishburn).

Direct application of the expected utility hypothesis (Kaylen et al.) can be numerically complex and costly, however, and has only recently become practical from a computing standpoint. Further, the results are typically questioned because of the imposition of a particular functional form for utility. Mean-variance models tend to be more tractable, but also suffer the restrictive assumption of a particular utility function. However, recent work by Meyer (1987) indicates that a larger number of utility functions may be consistent with the mean-variance technique.

Compared to direct utility maximization or mean-variance models, stochastic dominance techniques require very mild assumptions about agent preferences. First degree stochastic dominance (FSD) requires only that agents prefer more to less. Second degree stochastic dominance (SSD) additionally requires that agents be risk averse. These assumptions allow the comparison of distributions of net returns over a larger set of utility and preference characteristics without the direct specification of the functional form of an economic agent's utility. In addition, Meyer (1977) developed stochastic dominance with respect to a function that allows for the comparison of distributions over explicit ranges of risk aversion coefficients. Unfortunately, because of the general nature of stochastic dominance analysis, often no single dominant strategy is identified. Instead, a set of strategies is identified as being dominant to inferior strategies.[1]

The determination of FSD efficient strategies results from a comparison of the cumulative probability density functions (CDFs) for the returns under the different strategies (Anderson et al., King and Robison). Assume that the decision maker is faced with two investment opportunities, F and G. Further, the probability density functions for these investments can be expressed as f(x) and g(x), respectively. Then F dominates G in the first degree if

$$(1) \quad \int_{-\infty}^{r} f(x)dx \leq \int_{-\infty}^{r} g(x)dx$$

for each outcome, r, with at least one strict inequality. Alternatively, equation (1) can be rewritten as,

$$(2) \quad \int_{-\infty}^{r} [f(x) - g(x)]dx \leq 0.$$

Intuitively, this condition states that F dominates G if the probability of earning a specific return is equal for F and G and is higher at least at one point for F.

Similarly, one distribution is said to dominate another in the second degree if the area under the dominant CDF is less than the area under the dominated CDF. Mathematically, F dominates G in the second degree if

$$\int_{-\infty}^{r}\int_{-\infty}^{r} [f(x) - g(x)]dxdx \leq 0 \text{ or}$$

$$(3) \quad \int_{-\infty}^{r} [F(x) - G(x)]\, dx \leq 0$$

$$\text{where } F(x) = \int_{-\infty}^{x} f(s)ds \text{ and } G(x) = \int_{-\infty}^{x} g(s)ds$$

with at least one strict inequality where F(x) and G(x) are the respective CDFs for the two investments. Intuitively, if economic agents are risk averse, then their ordering is consistent with SSD. FSD simply requires that economic agents be insatiable. SSD efficiency additionally requires that economic agents prefer a lower cumulative probability of lower outcomes. Under certain assumptions, SSD efficiency closely resembles mean-variance efficiency.

This study also considers stochastic dominance with respect to a function (Meyer 1977). Stochastic dominance with respect to a function is a form of SSD which explicitly incorporates a range of risk aversion coefficients. Specifically, F dominates G

[1] While both the direct maximization and mean-variance models allow for a particular "optimal" action, the typical application of these techniques results in an efficient set of actions that depend on the producer's risk aversion coefficient. Thus, the inability of stochastic dominance to identify a single optimal strategy may not be much cause for concern.

over the range of risk aversion coefficients $[r_L(x), r_U(x)]$ if

$$(4) \quad \int_{-\infty}^{\infty} [F(x) - G(x)]u'(x)dx \leq 0$$

$$\text{such that } r_L(x) < \frac{u''(x)}{u'(x)} < r_u(x)$$

where u(x) is the utility function generated by the monetary outcome x. The relationship must hold with at least one strict inequality. FSD can be placed in Meyer's framework by letting $r_2(x) = -\infty$ and $r_u(x) = \infty$. Similarly, SSD sets $r_2(x) = 0$ and $r_u(x) = \infty$. Thus, stochastic dominance with respect to a function allows the researcher to examine the implications of a more narrowly defined range of risk aversion when comparing distributions of risky outcomes.

INTEREST RATES AND RETURNS

The stochastic dominance procedures outlined in the preceding section are typical approaches to analyzing risky alternatives in agriculture. This study's point of departure involves the integration of stochastic interest rates into the choices among marketing instruments. Specifically, the inclusion of stochastic interest rates is important to this analysis because, in theory, the futures price at any point in time is directly related to the carrying cost between the date of contract and the date of sale (Tomek and Robinson). Specifically, if the expected price of frozen concentrated orange juice (FCOJ) in nine months is $1.25 per pound solid and the interest rate is 12 percent, then $.1125 per pound solid of the basis can be attributed to the cost of capital. If the interest rate declines from 12 percent to 10 percent, the basis would theoretically narrow $.025 per pound solid or $375 per standard contract.

The effect of the interest rate on the choice of marketing instrument in this study is incorporated through return to management and owned capital. The return to management and capital for the i^{th} marketing instrument in time period t, R_t^i, can be expressed as

$$(5) \quad R_t^i = P_t^i Y_t - V - Dr_t$$

where P_t^i is the price of oranges received in year t in real dollars under the i^{th} marketing strategy, Y_t is the yield of oranges in year t, V is the constant real variable cost of production, D is the debt position, and r_t is the real interest rate in period t. One can see how returns to management and owner capital will change with changes in the interest rate and debt position.

METHODOLOGY AND DATA

Three marketing strategies were analyzed for a representative grove. The grove was assumed to consist of 150 acres of mature orange trees valued at $10,550 per acre. Variable costs were assumed to be $748.10 per acre (Muraro et al.). The marketing strategies considered included cash marketing, the cash market with a FCOJ futures market hedge, and a season average market pool with other citrus producers.

Annual net returns to the citrus grove were calculated for each marketing strategy for three marketing periods within each crop year. The data used to calculate these returns were from the 1970-1971 to 1987-1988 marketing years. The marketing periods evaluated within each crop year were December, February, and April. Different varieties were marketed in each period because of differences in maturation dates for each type of orange. In addition, weather may have affected the crop differently depending on its maturity. Thus, this analysis really looked at three representative farms, each producing a different variety of orange to be marketed in a different month.[2] The returns for each of these representative farms under the alternative marketing instruments were adjusted to 1988 dollars using the personal consumption expenditure component (PCE) of the implicit gross national product deflator. The distributions of net returns under the three marketing instruments for each representative farm were then compared using stochastic dominance to determine if a dominant marketing strategy existed for each marketing period.

The three marketing strategies were also compared at five different debt-to-asset ratios (0, .30, .40, .50, and .60) to evaluate the importance of interest correlation with the returns of a particular marketing strategy. These debt levels are typical for orange groves in Florida as suggested by the Federal Land Bank regional office in Lakeland, Florida. A zero debt case is included to illustrate the case where the interest rate would have no effect on marketing strategy.

[2] The reason for describing the study as analyzing three alternative farms is to rule out diversification opportunities between varieties. In Florida there are two major varieties of oranges produced, Hamlin and Valencia. The Hamlin orange is an early season orange that is lower in quality but higher in yield. Valencia oranges mature later in the season and yield a higher quality fruit. Due to differences in freeze risk between the two varieties and certain price considerations, diversification opportunities may exist between varieties. However, because this study focuses on the effect of capital structure on the choice of marketing instrument, this diversification opportunity is eliminated by the assumption of three representative farms.

Table 1. Calculated Real Net Returns to Each Marketing Strategy

Marketing Year	Net Return to Assets Cash Marketing			Net Return to Assets Hedge Marketing			Net Return to Assets Participating		
	December	February	April	December	February	April	December	February	April
	1988 dollars								
1970-71	(42,028)	22,067	41,463	(37,844)	(1,310)	(6,118)	22,654	42,117	13,876
1971-72	51,314	84,157	74,521	15,485	91,258	87,330	36,891	70,035	76,402
1972-73	37,974	69,777	57,937	39,792	67,604	66,377	51,459	81,705	74,151
1973-74	49,137	78,482	39,809	22,325	62,212	55,131	32,732	66,540	40,270
1974-75	30,416	37,691	39,832	40,000	59,480	57,953	37,547	60,487	47,723
1975-76	66,121	105,637	96,197	57,536	98,192	105,889	38,055	65,317	43,377
1976-77	(9,981)	(18,793)	37,146	70,127	(34,311)	(17,506)	190,472	140,558	74,445
1977-78	184,283	232,461	202,225	85,615	102,062	126,322	206,872	226,929	214,080
1978-79	198,364	280,230	202,217	144,017	223,274	163,164	210,661	261,653	202,967
1979-80	210,971	243,206	170,896	205,985	274,912	200,972	204,550	248,902	176,012
1980-81	120,672	167,917	130,071	175,824	82,376	39,733	196,263	172,415	70,831
1981-82	119,355	120,379	64,296	155,233	163,091	110,899	90,020	76,223	18,863
1982-83	126,105	129,259	172,717	151,999	163,337	203,991	102,368	120,368	151,192
1983-84	79,886	160,641	105,636	25,571	59,788	(13,906)	212,582	205,300	133,871
1984-85	267,867	220,283	176,292	266,504	246,148	191,684	170,451	141,543	108,247
1985-86	113,328	132,432	105,461	192,117	239,728	170,836	115,436	122,853	89,345
1986-87	110,238	171,315	139,462	57,696	137,747	97,765	94,981	118,663	89,842
1987-88	203,892	313,329	353,415	150,586	254,629	288,469	184,669	257,499	203,091
Average	106,551	141,711	122,756	101,032	127,256	107,166	122,148	137,771	101,588
Std. Dev.	80,459	88,455	79,156	79,156	88,516	81,860	71,872	72,072	62,479

The cash market prices used were those of the last week of each marketing period. The futures contract was assumed to be for the month following the marketing month and was opened ten months earlier. For example, the January 1988 contract was to be sold in March 1987 and offset in December 1987. The futures contract was for 15,000 pound solid of FCOJ. The broker's fee was $75 per turn with a five percent margin requirement. The interest rate charged to the producer on the margin requirement was the real interest rate from the Federal Intermediate Credit Bank (U.S. Department of Commerce).[3] The participation pool price used was a season average pool price based on orange juice received throughout the marketing year.[4]

The yield in boxes per acre for the grove was based on state averages (Florida Agricultural Statistics). The average early and mid-season orange yields were assumed to come from the December and February marketing periods, while Valencia orange yields were the basis for the April marketing period. Yields of juice in pound solids were calculated for the specific varieties based on the number of boxes and the squeeze percentage for each year (Florida Citrus Processors Association). The annual net returns given these assumptions and zero debt are presented in Table 1.[5]

[3] The authors recognize that a farm-level interest rate would be preferred. However, such an interest rate is not available. It is felt that the aggregate interest rate represents the correlation of farm level interest rates with FCOJ prices as well.

[4] A wide variance exists regarding the paymnet of pool proceeds for citrus. Typically, participants receive half of the proceeds when the fruit is delivered and the remaining balance when the pool is closed. In this study we assume that special pools exist which close within the marketing period. Thus, the participant is assumed to receive all the proceeds from the sale of the fruit in the month that the fruit is delivered.

[5] In order to test whether some time adjustment on yield was required, a regression was performed to determine whether the yield per acre changed significantly over time. The results for this regression indicate that no significant trend in orange production per acre occurred over the time period. In addition, recent results from Moss et al. suggest that a two-step procedure intended to remove upward trends in yield may have undesirable consequences for the density function being analyzed.

Table 2. Correlation Between Gross Returns and Interest Rates

Month	Marketing Strategy		
	Cash	Hedge	Participation
December	.30672 (.2157)[a]	.40927 (.0917)	.15524 (.5385)
February	.17772 (.4805)	.36204 (.1398)	.02054 (.9355)
April	.20566 (.4130)	.29113 (.2412)	.08529 (.7356)

[a]Numbers in parentheses are the probabilities the correlation coefficients are equal to zero.

The risk aversion ranges used in the stochastic dominance with respect to a function analysis in this study were adapted from Boggess and Ritchie. Specifically, Boggess and Ritchie's risk aversion ranges were adjusted for the size of the gamble by dividing by the level of wealth consistent with Raskin and Cochran (1986a).

First and second degree stochastic dominance along with stochastic dominance with respect to a function analyses were then performed on the set of three marketing strategies in each marketing period for each assumed debt level. The analysis used computer software developed by Raskin and Cochran (1986b).

RESULTS

The correlation between returns and interest rates appears to be significant, especially for cash and futures strategies (Table 2). The correlation also tends to be higher for the December marketing period. This suggests that optimal marketing strategies may change as debt increases. However, the FSD and SSD results do not support this conclusion (Table 3).

No ranking of marketing strategies is possible using FSD as can be seen visually from the CDFs plotted in Figures 1-3 since no CDF lies entirely to the left of the other density functions. However, if risk aversion is assumed, some marketing strategies can be eliminated. As indicated in Table 3, the strategy of marketing pool participation dominates the other marketing strategies for the December marketing period while cash marketing dominates in the April marketing period. Only in the February marketing period is more than one strategy efficient; both cash marketing and marketing pool participation dominate the use of futures market hedges.

The results are somewhat consistent with those found by Moss and van Blokland which indicate that both hedging and cash marketing strategies are efficient in December with hedging preferred at lower levels of risk aversion. Cash marketing, on the other hand, is preferred by more risk-averse producers. However, the results from the current research indicate that cash marketing is preferred to hedging at all levels of risk aversion. These results also indicate that both cash marketing and pool participation are efficient in the February marketing period.

Table 3. Second Degree Stochastic Dominant Strategies at Each Solvency Position

Solvency Ratio (In Percent)	Marketing Strategies		
	Participation	Cash	Hedge
December			
0	X		
30	X		
40	X		
50	X		
60	X		
February			
0	X	X	
30	X	X	
40	X	X	
50	X	X	
60	X	X	
April			
0		X	
30		X	
40		X	
50		X	
60		X	

The results presented in Table 3 make intuitive sense from the standpoint of the citrus producer. Typically, cash prices at the end of December are lower than the marketing year average that the participation pool would generate. Consequently, grove owners producing early fruit would be more likely to participate in a marketing pool. This would be especially so given the probability of freezing weather damaging the crop of later varieties after the early varieties have been harvested, thus increasing the season average price for producers of earlier fruit. The opposite case is true for producers of late maturing orange varieties. Grove owners with Valencia trees would be more interested in selling in the cash market so that higher late season prices would not be diluted by the lower average pool price.

The results of stochastic dominance with respect to a function presented in Table 4 indicate that the efficient marketing instrument changes from pool

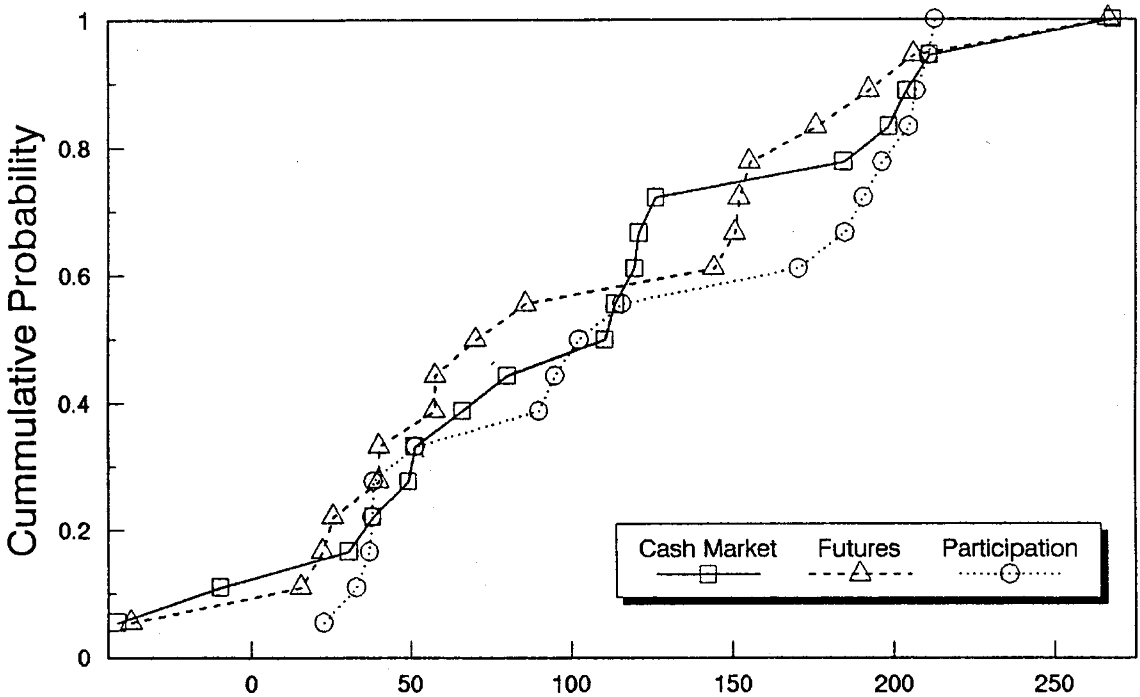

Figure 1. Probability Density Function for Marketing Strategies in December

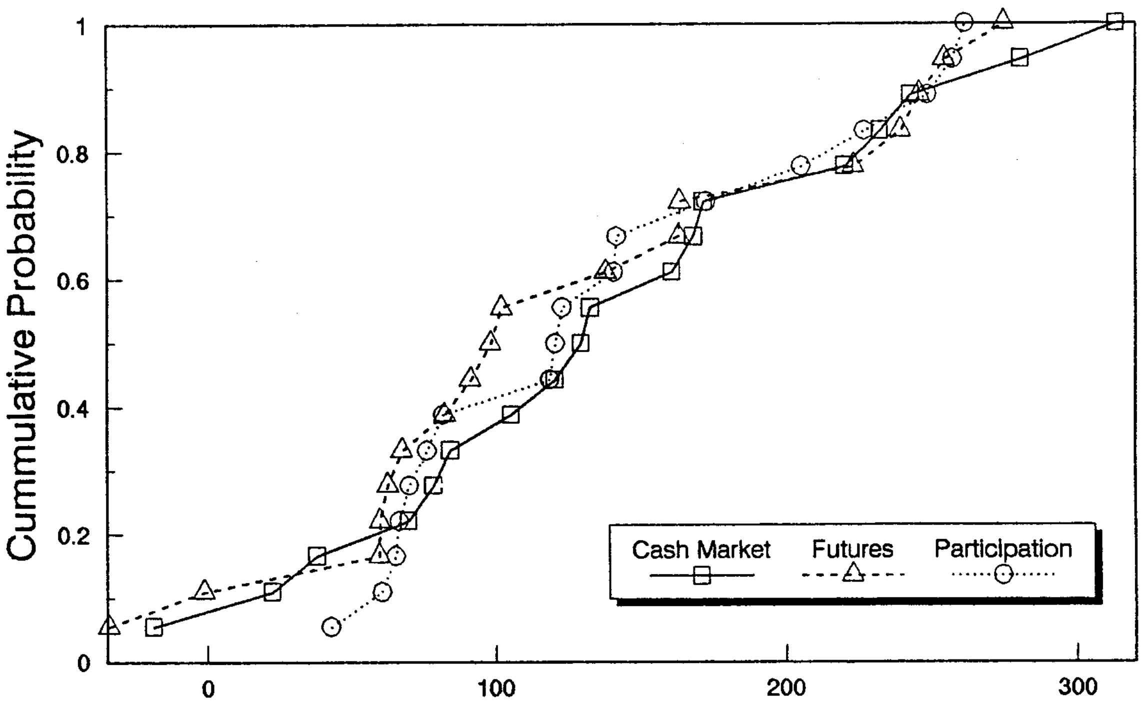

Figure 2. Probability Density Function for Marketing Strategies in February

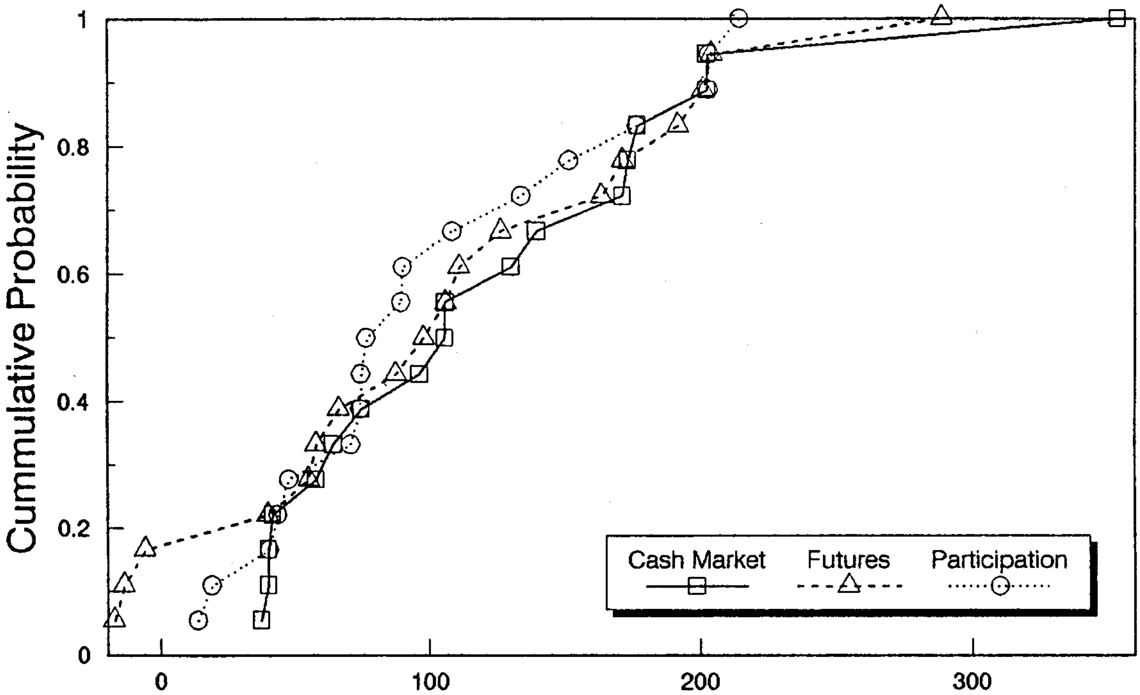

Figure 3. Probability Density Function for Marketing Strategies in April

Table 4. Results of Stochastic Dominance with Respect to a Function for Various Debt Levels in the February Marketing Period

Solvency Ratio (In Percent)	Marketing Strategies		
	Participation	Cash	Hedge
r(x) [.000002, .000003]			
0	X	X	
30		X	
40		X	
50		X	
60		X	
r(x) [.000003, .000004]			
0	X		
30	X	X	
40	X	X	
50		X	
60		X	
r(x) [.000004, .000005]			
0	X		
30	X		
40	X		
50	X	X	
60	X	X	

participation to cash marketing as the debt position increases in the February marketing period. Further, the risk aversion ranges necessary for this switch are in the range that Boggess and Ritchie term moderately risk averse. Thus, the results do not represent an unlikely risk attitude for the producer. The results also are consistent with how citrus producers are expected to respond to risk. They indicate that producers with greater aversion to risk will tend to take greater advantage of marketing pools and avoid the cash market.

At first glance the results in Table 4 appear to contradict the concept of risk balancing as advanced by Gabriel and Baker and Collins. Specifically, at higher debt levels the producer in the February marketing period switches to the riskier marketing strategy. However, there are two divergences between the current case and the scenario advanced in previous literature. First, the risk-balancing hypothesis allows the producer to control risk through two mechanisms: the choice of debt and the choice of marketing instrument. In this study debt is fixed. Thus, we have eliminated risk balancing. Second, the interest rate is stochastic and positively correlated with the returns to citrus (Table 2). Thus, when interest rates are high, orange prices tend to be high. Since cash prices are more highly correlated with interest rates than pool participation, the cash marketing option allows the producer to cancel relatively more interest rate risk at high leverage positions.

CONCLUSION

The results of this study confirm that the optimal marketing instrument may depend on the firm's debt position, consistent with the findings of Moss and van Blokland. Specifically, participation is preferred with lower levels of debt in the February marketing period, while at higher solvency ratios, cash is the preferred strategy. However, these results require that the producer be moderately risk averse. More global risk aversion ranges such as FSD and SSD are not sufficient to depict the change in marketing strategy with changes in debt position.

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