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by

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Price forecasts can be valuable to producers, traders, processors and other agricultural commodity market participants. Viewed within a decision making framework, accurate forecasts can result in more efficient production and marketing decisions, improved resource allocation and improved returns distributions. For the decision maker, assessment of the attractiveness of forecasts can be greatly facilitated by providing information about the range and probabilities of outcomes (returns) associated with alternative forecasts, market strategies and market signals.

Considerable research has been conducted comparing the forecasting ability of futures markets to various forecasting techniques (Just and Rausser; Leuthold and Hartmann; Garcia et al., 1988a). Most of these studies have been conducted to assess the ability of the forecasting techniques to out perform futures markets in a statistical sense. Recently, researchers have begun adopting tests of economic significance to assess the existence or lack of profitable market opportunities from the use of these improved forecasts (e.g., Cumby and Modest). While this work has permitted an interesting assessment of the performance of various futures markets, it has provided only limited information to the decision maker about the distribution of returns from the use of forecasts in specific futures markets and on the factors (e.g., characteristics of the trading rules, month effects) influencing trading profitability. Clearly, developing a better understanding of the returns distributions and the factors that influence profits for various marketing opportunities is important for evaluating the attractiveness of alternative forecasts and market positions.

The purpose of this paper is to identify more carefully the returns distributions of various trading strategies in the live hog futures market. An additional focus of the work includes the identification of factors influencing profitability of various trading strategies. Simple trading rules are constructed based upon a comparison of the out-of-sample cash price forecasts with a basis-adjusted futures market price. Returns from trading strategies are calculated for various forecast horizons and examined for normality. Returns per contract are compared with the size of signal (i.e., the difference in absolute terms between the price forecast and the basis-adjusted futures price) from the price forecast, and bootstrapping techniques are used to more carefully examine the returns distribution. Regression analysis is then used to quantify the relationship between contract

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returns and various characteristics of the trading activity (e.g., size of signal, buy or sell positions, and contract effects). In addition, the effects of various trading filters (i.e., one through three dollar differences between the price forecast and the market's forecast) on profitability of the trading strategy are quantified.

The findings provide insight into the distribution of returns from trading futures contracts conditioned on price forecasts and alternative trading strategies. They also permit an assessment of the relationship between the likelihood of profitable trades and the size of signal from the forecast model and other trade-related characteristics such as contract month. In this context, for example, it is possible to identify for the decision maker the probability of generating trades with an expected value greater than some specific level. Finally, the results provide information on the ability of the live hog futures contract to incorporate market information, particularly at more distant horizons.

Related Literature

The literature directly related to the distribution of returns from trading futures contracts is somewhat limited, but related work does exist. Recently, researchers have attempted to statistically determine the economic significance of profits from using forecasts in market situations. Using Henriksson-Merton tests and Cumby-Modest tests, researchers have examined the ability of forecasts to determine market situations to statistically predict whether profits can be generated. Specifically, these procedures attempt to ascertain if forecasts can accurately predict the direction of market change and the subsequent change in the magnitude of returns. For agricultural commodities, the results are not very definitive but suggest that the best forecaster on the basis of statistical criteria (e.g., mean squared error (MSE) or mean absolute error (MAE)) often does not coincide with the most attractive forecaster in terms of economic performance.

In work related to the efficient market hypothesis, the forecasting ability of futures markets also has been assessed using weak and semi-strong procedures.[1] Numerous studies on a variety of commodities have been performed which use statistical tests and measures such as MSE or MAE to determine if futures prices effectively incorporate available information. Evidence from a variety of studies suggests that commodities that are seasonally produced and continuously stored (e.g., corn and soybeans) appear to incorporate information more effectively than continuously produced nonstorable commodities (e.g., hogs and cattle). In addition, it appears that as the maturity approaches it is more difficult to generate substantive returns from trading futures contracts. Recently, several studies have attempted to determine if the risk-adjusted returns from the use of more accurate forecasting models exceed the model development and transactions costs (Leuthold et al. and Garcia et al., 1988b). The results are somewhat mixed but suggest that for the live hog futures contracts, in particular, the potential for profitable market activities exists.

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[1]See Buccola and Garcia et al., 1988a for a more complete discussion of the pricing efficiency of agricultural futures markets.

While these studies have begun to provide some insight into the possibility of generating profitable trading strategies using futures markets, they provide only limited information to the decision maker about the distribution of returns for various forecasts and futures market alternatives. Little is known regarding the factors which may influence returns from various futures contracts. Here, we provide information on the distribution of returns for trading live hog futures contracts conditioned on time series forecasts and particular marketing alternatives. Characteristics of the specific trade such as contracts effects, time horizons and the size of signal which influence the returns also are identified.

Methodology

The analysis is performed using data from 1976 to 1990 from the live hogs cash and futures market. Past research suggest this market does not effectively incorporate all available market information, particularly at more distant horizons (Leuthold et al. and Park et al.). A time series modeling procedure, which has been demonstrated to be an effective forecast procedure in this market, is used to generate out-of-sample forecasts of subsequent cash prices. These forecasts then are compared to a basis-adjusted futures price and simulated returns (profits or losses net of transaction costs) are calculated for various forecast horizons based on realized prices.

Estimation and Updating

A time series modeling framework was used to forecast cash hog prices.[2] Examination of the data indicated that the monthly price of hogs were stationary throughout the period of the analysis. Inspection of the partial autocorrelations and autocorrelations suggested the presence of a restricted autoregressive model. Two procedures were used to identify the exact forecasting specification. The first method selected the specification with the highest adjusted coefficient of determination provided with an acceptable Q-statistic. The second method selected the forecasting specification based on Akaike Information Criteria (AIC) which is an in-sample measure of forecast error. For all forecasting periods, both methods selected the same specification.

The initial analysis was performed with monthly hog data from January 1976 to December 1983. In the trading simulation it is necessary to generate for each month out-of-sample forecasts for up to six months into the future. The procedure followed in this is study is to drop the oldest observation as the new observation is added, keeping constant the number of observations in each estimation. To incorporate this new information, the model was re-estimated each period with the new data set. This procedure limits the memory of the system by totally discounting the most distant information, and permits the estimates of the structure to respond more quickly to fundamental structural changes than when old observations are retained (Harvey, 1981). The forecasting specification used here only changed once throughout the analysis; however, the estimated coefficients changed with the addition of the

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[2]The cash hog price is the USDA price of barrow and gilts, 7 markets, dollars per hundredweight.

new information over time. The updating, re-estimating and subsequent forecasting continues from January 1984 to December 1990.

In order to generate a comparable futures price, the monthly average futures price was adjusted by a forecast of the basis. Following previous research (Brandt; Park et al.), the expected basis for each contract is a simple average of the basis in the maturity month for the previous three years.

The Trading Simulation

The trading simulation procedure used the following contracts: February, April, June, August, October and December. The July futures contract is ignored for the convenience of constant forecasting and trading horizons. The trading simulation procedure was designed to buy a future contract if the forecast exceeds the adjusted futures, and sell if the forecast is below the adjusted futures. Specifically, starting with the two-month forecasts, if the forecast for the next delivery month is more than $0.25 per hundredweight (the approximate commission costs) above (below) the average corresponding basis-adjusted futures price during the forecasting month, a futures contract is purchased (sold) at the closing price of the next trading day and held until the close of the tenth day of the delivery month. If the forecast is within $0.25 per hundredweight above or below the average of the futures closing price, no action takes place. For example, at the end of December, forecasts become available for February. If the forecast is more than $0.25 per hundredweight above or below the average of the basis-adjusted February closing prices during the month of December, a trade occurs with a contract being initiated on the first trading day of January and liquidated on the tenth (or the nearest trading day) of February.[3] The profit or loss of this trade is recorded after deducting a commission cost of $0.25 per hundredweight.

Updated time series models are used for each forecast period. The process begins in December 1983, with the first two-month forecast for February 1984. This process continues every two months until December 1990, resulting in 42 potential transactions for the two-month time horizon.

The same procedure and signals are followed for the four-month forecasts. However, here there are two alternative procedures for liquidation. In the first, the contract position based on the initial signal is held until the maturity month, a period of more than three months, ignoring any new information. This procedures is called "fixed market strategy" and resulted in 41 transactions. In the second procedure, the initial position is held until the two-month forecasts are available, at which time the time series forecast is compared to the then existing futures price. If the signal is the same, no change in the position occurs. If the signal is different, then the original position is liquidated and a new one is established on the first trading day following the two-month forecast and signal. This procedure is called "flexible market strategy."

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[3] A single day is selected because market participants cannot trade the monthly average.

The procedures for the six-month forecasts are the same as for the four-month forecasts. Both the "fixed market strategy" and the "flexible market strategy" situations are calculated. Here, under the "flexible market strategy" it is possible to update the change positions at four and at two months prior to maturity.

Findings

Table 1 provides information on the returns from the simulated market activities. The total returns from the various strategies are always positive, generally positively skewed and appear to be normally distributed except perhaps at the four-month flexible strategy. Highest total returns, largest variability and the highest percentage of profitable trades appear at the more distant market horizons. For example, 75 percent of the trades in the six-month fixed strategy were profitable generating a total return of nearly fifty thousand dollars across 40 trades, an average return per contract of 1248 dollars with a standard deviation of 1835 dollars. In contrast, only 56 percent of the trades using the two-month strategy were profitable generating a total return of about fifteen thousand dollars, an average return per contract of 371 dollars with a standard deviation of 1173 dollars. The flexible strategies produced somewhat mixed results. The four-month flexible generates higher total and per contract returns than the four-month fixed, but the six-month fixed clearly outperforms the six-month flexible.

In order to provide additional insight into returns distribution, the relationship between the size of signal (the difference between the forecast and the basis adjusted futures price), the ability of the strategies to accurately identify profitable directional changes in the market, monthly contract effects and size of filters and the returns per contract for the various strategies were investigated. For purposes of exposition, the results from the four-month fixed horizon with a one dollar filter are presented. This strategy was selected because it represented somewhat of an intermediate returns distribution between the two- and six-month returns, and because the returns distribution and the residuals from the estimated relationships were nonnormal at the 10 percent level by the Jarque-Bera test. In this situation, bootstrapping provides a useful procedure to examine the distribution of the estimated coefficient and the returns distribution. It also is a convenient way to provide information to the decision maker of the likely outcomes from following these market strategies.

Figure 1 presents a scatterplot of the returns per contract and the size of signal. The regression line and selected statistics of the estimated relationship also are included. Overall, there appears to be considerable unexplained variation associated with the regression of size of signal on returns per contract (i.e., the adjusted coefficient of determination is rather small). However, a positive relationship between the size of signal and the returns per contract does exist. The estimated beta coefficient which indicates the effect of increasing the size of signal by one dollar on the returns per contract is 212. This figure is close to reflecting the expected value (225 dollars per contract) generated by a one dollar difference between the buying and selling price of a live hog futures contract.[4] Larger estimated beta coefficients were encountered at forecast horizons closer to maturity, i.e., the largest coefficient was found at the two-month horizon, followed by the four- and six-month horizons. Examination of the average returns per contract (table 1), scatterplots of the data and estimated relationships indicated that the shorter-horizon trades had more observations scattered around a return of zero associated with smaller measurements of the size of signal variable. However, for larger measurements of the size of signal variable, positive returns also were realized. In effect, the characteristics of the data for the shorter-horizon trades tilted the regression line resulting in a value of its constant near zero or negative and large value for the size of signal variable. In contrast, the six-month horizon had a mean return per contract considerably above zero. Even for many of the observations with smaller values of the size of signal variable, positive returns were realized. This had the effect of increasing the size of the constant term in the regression line and reducing the magnitude of the size of signal coefficient.

Figures 2 and 3 are histograms of the estimated beta for the size of signal and the returns distributions for the four-month fixed horizon strategy with a one dollar filter generated by the bootstrapping procedures.[5] Note in Figure 2 the average value of the beta is 216 with a standard error of 85 which is very close to the estimated values from the OLS equation (figure 1), indicating that here the effects of the nonnormality were not very severe. Figure 3 also appears to be rather normal with slight positive skewness and an expected value of 880 and a standard deviation of 775. Figure 3 provides potential useful graphical information about the probability of a profitable trade given the forecast, the strategy and specific filter rule used. Here, it demonstrates that while the likelihood of a profitable trade is quite large, that the risk of losing money with these strategies still exists. Such information from various trading strategies and forecasts can be used by the decision maker in assessing the expected profitability from market alternatives. Differences in the location and shape of the returns distribution can lead to the selection of alternative market strategies. For example, a risk averse decision maker may select a trading strategy which has very small probability of generating a loss rather than another strategy with a higher probability of a loss but a higher expected gain.

Table 2 presents information from including a buy/sell and monthly dummy variables in the estimated relationship. The buy/sell dummy variable takes on a value of one when the forecast model indicates a buy strategy and zero when it indicates a sell strategy. The estimated coefficient of the buy/sell variable can be zero in two cases. First, if the forecast provides little information on the direction of the market change both buying and selling positions result in zero gains, and its value will be zero. Second, if the

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[4] A live hog contract is 300 hundredweight. A one dollar difference between the buying and selling price of the contract results in a 225 dollar gain (300 dollars less 75 dollars commission costs [75 dollars = $0.25 hundredweight x 300]).

[5] The beta distribution is based on 1000 observations, while the returns distribution is based on 3800 observations. See Judge et al. for a discussion of the bootstrapping procedures used here.

forecast provides valuable information about the change in the market, it is still possible that its coefficient can be zero if the gains from buying and selling are equal. Results from the estimated relationships suggests that the time series models provide valuable market information about the direction of market change and that returns from buying systematically were larger than the returns from selling. This fact suggests that the forecast model was able to more accurately predict increasing prices, and that the during periods of the year the futures prices were systematically lower than the subsequent cash.

The monthly dummy variables were specified with the August contract as the base month. August was selected because of the rather large systematic gains associated with the transactions based on contracts maturing in that month. The signs of the other contract months suggest that relative to August, the December, February and April contracts were least profitable. Trades in the June and October contracts also were somewhat less profitable, although not in a statistical sense. The explanation for why these summer and fall contracts are more profitable than the other contracts during the year is not clear, but may be related to seasonality in hog marketings and pork demand.

Table 3 provides the results associated with various filtering rules for the four-month fixed horizon. Specifically, it is possible to identify the effects of increasing the filter from zero to three dollars. In general, the adjusted coefficient of determination remains about the same, and the size of signal remains positive and significant. The coefficient associated with buy/sell dummy variable remains positive but declines somewhat in importance.

Conclusions

Evaluation of attractiveness of forecasts is facilitated through identification of the returns distribution associated with alternative forecasts and marketing strategies. This paper investigated the returns distribution generated from time series models and the implementation of simple trading rules in the live hog futures market. In addition, factors were identified which influenced the profitability of various trading strategies.

Based on the out-of-sample analysis, the potential for positive returns continues to exist in the live hog futures market, particularly at more distant contracts. The returns distributions for the forecasts and strategies considered here appeared to be positively skewed but in general could not be statistically distinguished from the normal distribution by the Jarque-Bera test. Higher returns in the more distant contracts were associated with the largest variability and the highest percentage of profitable trades. The effect of flexible marketing strategies which permitted re-evaluation of market positions based on changing market information were mixed.

Higher per contract returns are positively related to the size of signal, and the ability to accurately predict the direction of market changes. Higher per contract returns also appear to be more likely to occur in the summer and early fall contracts. Increasing the size of the filter tends to eliminate unprofitable trades and strengthens the importance of the size of signal on returns.

Finally, returns distributions can be developed to assist decision makers in identifying the probability associated with generating profitable trades and for selecting among alternative market opportunities. That is, it is possible to identify profitable regions of the returns distribution, and their associated probabilities. This technique can permit various decision makers with differing motivations to select market positions and forecasts consistent with their incentives.

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Table 1: Simulation Results from Trading Live Hog Futures Contracts: (1984-1990)

Model Type and Horizon	Profitable Trades	Percent Profitable Trades	Total Returns	Mean Return	Standard Deviation	High Return	Low Return	Skew-ness	Kurto-sis	Jarque Bera[a]
2-Month Fixed	23	56%	15,213	371.05	1,173.39	2,955	-1,500	0.29	2.11	3.40
4-Month Fixed	26	63%	35,082	855.66	1,693.58	5,130	-2,700	0.35	2.83	2.47
6-Month Fixed	30	75%	49,923	1,248.08	1,835.50	5,634	-2,601	0.35	2.73	2.45
4-Month Flexible	32	67%	46,185	962.19	1,453.53	3,756	-3,030	0.61	3.17	4.22
6-Month Flexible	37	62%	44,463	741.05	1,659.32	3,831	-2,439	-0.03	3.37	0.04

[a] The Jarque-Bera test has a Chi-Square distribution with 2 degrees of freedom. The critical value at the 10% level is 4.61.

Table 2: OLS Results for Four-Month Fixed Horizon with $1 Filter[a]

#	Constant	Signal	Buy/ Sell	Contract Month Dummy Variables: Feb	Apr	Jun	Oct	Dec	Adj. R-Squared
I	-400.52 (570.88)	212.46 (83.23)							0.130
II	-991.15 (645.16)	210.41 (80.85)	956 (534)						0.180
III	632.69 (844.99)	182.10 (75.14)	1,263 (516)	-2,359 (902)	-2,278 (863)	-1,057 (871)	-1,450 (888)	-2,337 (889)	0.306

[a] The August contract is the base month for the contract month dummy variables. The numbers in parentheses are standard errors.

Table 3: OLS Results for Four-Month Fixed Horizon with Different Filters [a]

Filter	# of Obs.	Constant	Signal	Buy/ Sell	Adj. R-Squared
$0.00	41	297.71	200.44	1,156	0.293
		(662.87)	(66.39)	(481)	
$1.00	38	632.69	182.10	1,263	0.306
		(844.99)	(75.14)	(516)	
$2.00	36	792.75	165.34	1,141	0.225
		(887.73)	(82.01)	(538)	
$3.00	32	-602.39	269.77	608	0.236
		(994.20)	(91.16)	(582)	

[a] Monthly contract dummy variables were included in the estimation but are omitted here. The numbers in parentheses are standard errors.

Figure 1: Four-Month Fixed Horizon with $1 Filter

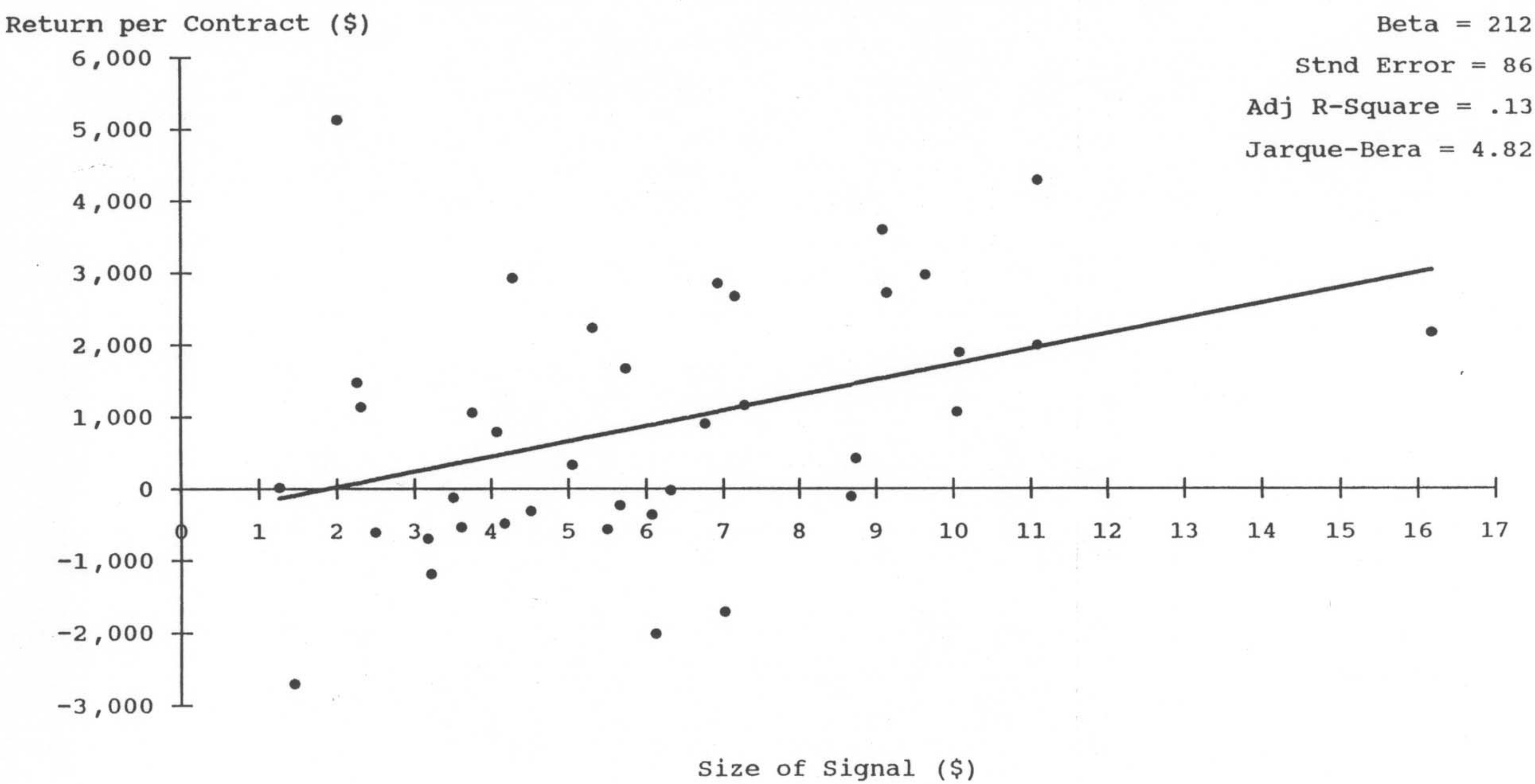

Figure 2: Returns Distribution for the Four-Month Fixed Horizon with a $1 Filter

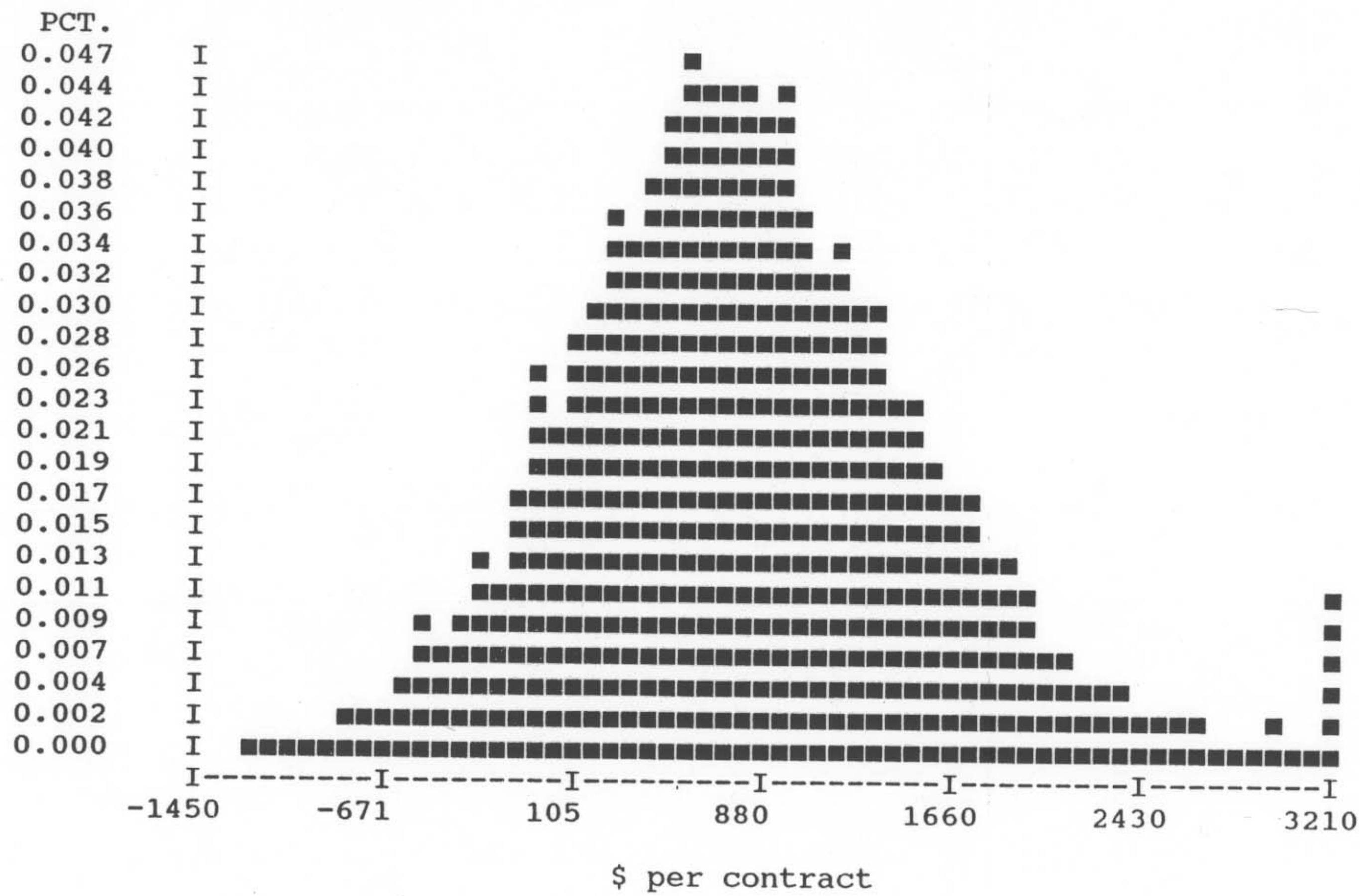

Figure 3: Beta Distribution for the Four-Month Fixed Horizon with a $1 Filter