Excess Returns from Custom Cattle Feeding?

by

Emmett Elam and Charles Dodson

Excess Returns from Custom Cattle Feeding?

Emmett Elam and Charles Dodson*

A problem facing feedyard managers is the ability to attract outside investment in the form of custom feeders (Kay). Custom feeders are utilized by feedyard managers as a method of reducing the price risk associated with holding large numbers of cattle. Custom feeders retain ownership of cattle which are placed in the feedyard; and, therefore, accept the price and production risk associated with feeding those cattle. For a fee, the feedyard will feed and manage the cattle for the investor. In return, the custom feeder receives any residual returns.

The last few years have seen a decline in investor interest in feeding cattle resulting in feedyards accepting larger levels of risk. There are several possible reasons for the decline in investor interest--e.g., changes in tax laws limiting the use of cattle feeding as a tax shield and increased conservatism among investors and lenders. Risk-return characteristics of investments have historically been one of the major factors used to explain the behavior of investors. Investors will choose to include custom cattle feeding in their portfolios only if custom cattle feeding has attractive risk-return characteristics. Analysis of the risk-return characteristics for custom cattle feeding would identify the benefits of cattle feeding investment strategies for both feedyard managers and outside investors.

This research examines the risk-return characteristics of custom cattle feeding. The historical returns to custom cattle feeding over the 1980-1992 period are estimated and compared to returns from alternative investments over the same period. Subsequent sections will examine the relationship between risk and return for cattle feeding using the Capital Asset Pricing Model (CAPM) and Arbitrage Pricing Theory (APT). A final section will discuss implications of the results for investors and for feedyard managers.

Previous Risk-Return Studies

There have several studies of the risk-return characteristics of agricultural assets. The first attempt to evaluate the required return for an agricultural investment was Barry's pioneering CAPM study of farmland. He regressed the earnings and capital gains from farmland on the Standard and Poor's 500 Index and found little systematic risk. Using the CAPM framework, Dusak and Elam and

*Associate Professor of Agricultural Economics, Texas Tech University, and Agricultural Economist in the Agricultural and Rural Economy Branch of USDA's Economic Research Service. Junior authorship is not assigned on this paper.

Vaught found little systematic risk in wheat, corn, soybeans, cattle, and hogs. Arthur, Carter, and Abizadeh utilized both an arbitrage pricing theory (APT) framework and the CAPM to examine the systematic risk of 25 agricultural commodities. Their analysis indicated that none of the agricultural assets examined (which included cattle) contribute systematic risk to a diversified portfolio.

Because agricultural assets have little systematic risk, financial theory indicates that the required rate of return to hold any agricultural asset should be only slightly above the riskless rate. Any return greater than the required rate is an excess return and is an indication of market inefficiency, i.e., the asset is underpriced relative to its risk (Jensen). Many studies of the risk-return characteristics of agricultural assets have found that agricultural assets are underpriced relative to their risks (Moss, Featherstone, and Baker; Barry; Irwin, Forster, and Sherrick). However, the excess return may be due to high transactions cost or illiquidity, as pointed out by Barry. For example, an investor in farmland would require compensation in addition to the required return to compensate for transactions costs such as sales commissions and search costs.

A recent study by Bjornson and Innes used both a CAPM and APT framework to test whether mean returns on agricultural assets have been higher or lower than those of comparable risk assets in non-agricultural markets. They structured their study to account for the tendency for low-beta securities to exhibit higher returns than the CAPM predicts (see references in Bjornson and Innes). Their results indicated that returns to farmer-operators have been lower than for comparable risk non-agricultural assets while those to landlords have been higher. Bjornson and Innes also found that agricultural assets, when held by landlords, contributed little systematic risk to a well-diversified portfolio. Though not conclusive, Bjornson and Innes' results provide indications of systematic risk when agricultural assets were held by farmer-operators.

The problem of illiquidity is also discussed by Collins who argues that since the popular market models (APT, CAPM) make no provisions for illiquidity, the required rate of return for agricultural investments should only be estimated from liquid agricultural investments. Collins cautions against analysis of systematic risk characteristics for agricultural assets using the CAPM or APT. "The systematic risk(s) of publicly traded ownership interests in assets may be very different from the systematic variation in the income stream of the assets." This would imply that the application of a market model to agricultural assets will provide information only on the systematic variation of that income. Should a publicly traded ownership of that income stream be created, the systematic risk may be entirely different. Stock market studies, for example, have shown that the systematic risk of dividend income is less than the systematic risk of the stock (Collins).

There are very few publicly traded agricultural investments. Any analysis utilizing either CAPM or APT will only provide information on the systematic risk of the income streams. For example, analysis of custom cattle feeding returns will provide information on the systematic risk of the feeding returns but not on the systematic risk of the stock of a publicly owned feedlot. A custom cattle feeder, however, is only interested in the systematic risk of the feeding returns.

Custom Cattle Feeding Returns

Previous studies show that custom cattle feeding returns vary by season, with highest returns in April-June and lowest returns in September-January (Trapp; Cattle-Fax). A recent study by Langemeier, Schroeder, and Mintert used fed cattle customer closeout sheet data from a feedyard in western Kansas to estimate the impact of price and performance variables on profits per head from finishing steers. Their study was designed to explain variation in feeding returns over time and not to estimate the rate of return. Derived rates of return for the study period 1980-1989 range from 19-23% per year, depending on the cattle placement weight.

A recent study by Miller analyzed the investment potential of cattle feeding and compared returns from cattle feeding with stocks. Using private accounting data from selected Texas-Oklahoma feedyards, Miller estimates a compound rate of return from cattle feeding of 14.2% over 1985-1990. This compares with a 16.2% compound return received from the Standard and Poor's 500 Index over the same time period.

The studies by Trapp and by Miller both utilized proprietary information. Both sets of returns were calculated using accounting data obtained from privately owned feedlots located in the High Plains. This study, however, utilizes publicly available data obtained from published reports to calculate custom cattle feeding returns for a 13-year period (1980-1992). Monthly feedyard performance data for High Plains fed cattle were taken from Feedstuffs. Fed cattle prices for the Texas-Oklahoma Panhandle were obtained from Agricultural Marketing Service (AMS) published reports. Feeder cattle prices were obtained from AMS published series for Amarillo, Texas, and Dodge City, Kansas, auction markets. Full documentation of the procedure utilized to estimate custom cattle feeding returns is reported in Dodson and Elam. The results indicate that unleveraged cattle feeding returned an average of $25.26 per head for steers over 156 feeding periods.[1] Heifers provided higher returns with an estimated average return of $30.61 per head over all feeding periods.

---

[1]Unleveraged cattle feeding refers to 100% equity in the feeder animal. We assumed that 100% of the feeding cost including ration cost, medicine and yardage was financed.

The return on investment for cattle feeding was defined as the net return per head divided by the cost of the feeder animal. Analysis of investment returns for cattle feeding indicated that returns on investment for cattle feeding were greater than the returns received from alternative investments (Table 1). Annual return over the period was 13.0% for steers and 18.4% for heifers, which was highest of any investment analyzed. For example, stocks returned between 17.1 and 17.7% per year (Ibbotson Associates). If cattle feeding is similar to all other agricultural investments in that it has little systematic risk, the results in Table 1 indicate custom cattle feeders are receiving excess returns.

Capital Asset Pricing Model

The CAPM has been a very useful model for examining the systematic risk of investments. It has been criticized on several grounds, however (Roll). One major criticism has been reliance on a market portfolio. Roll's critique stated that any test of the CAPM was actually a test of the efficiency of the market portfolio. Since the market portfolio included assets that could not be easily measured such as commodities, home equity, and human capital, empirical applications of the CAPM were not reliable. However, Black argues, "To the extent that stocks of commodities are held by corporations, they are implicitly included in the market portfolio." Using this argument, Roll's critique can be circumvented and the CAPM can be used to measure systematic risk and, in the case of publicly traded assets, the efficiency of asset pricing.

The CAPM shows that equilibrium rates of return on individual assets adjust to levels that reflect the risk which each asset contributes to a market portfolio of all assets. Investors holding such portfolios need only require compensation for the total market, or systematic risk, that is common to all assets in the portfolio and that cannot be diversified away.

The general form of the CAPM is:

$$(1) \quad E(R_i) = R_F + [E(R_M) - R_F]\beta_i,$$

where $E(R_i)$ is the expected return on asset i; R_F is the risk-free rate of return; $E(R_M)$ is the expected return on the mean-variance efficient market portfolio; and β_i is $cov(R_iR_M)/var(R_M)$, the systematic risk of asset i. In empirical analysis, the model is modified to the excess returns approach:

$$(2) \quad R_{it} - R_{Ft} = \alpha_i + \beta_i(R_{Mt} - R_{Ft}) + e_{it},$$

where R_{it}=rate of return from investment in cattle feeding for period t; R_{Ft} =risk-free rate earned on Treasury bills for period t; R_{Mt} = rate of return from investment in the Standard and Poor's 500 Index of stocks including dividends; e is a random error term; and α and β are fixed intercept and slope parameters, respectively.

The anticipated value of α is 0, and positive estimates imply custom cattle feeders are receiving returns in excess of that required to compensate for systematic risk. It was expected that if cattle feeding had little systematic risk, β would not be significantly different from 0.

CAPM Results

In calculating the cattle feeding return used to estimate equation (2), it was assumed that (i) borrowed money was used to pay the feeding cost (including ration cost, working cost, medicine, and yardage); (ii) the cattle feeder made a 100% investment in the feeder animal; and (iii) the feeding period was five months in length. R_{it} was calculated as the percentage return on the investment in the feeder animal. R_{Mt} and R_{Ft} were calculated as percentage rates of return for a five-month period.

Data for the period 1980-1992 were used to estimate equation (1). As mentioned above, feeding returns were calculated for the usual five-month feeding period that feedlot cattle are fed. The first five-month feeding period began in August 1979 and ended in January 1980. The last five-month feeding period began in July 1992 and ended in December 1992. Feeding returns were calculated for a total of n=156 feeding periods for both steers and heifers. R_{Mt} and R_{Ft} were calculated for 156 five-month periods also.

Equation (1) was first estimated using ordinary least squares (OLS). Autocorrelation was present in the residuals because of overlap in the feeding periods. For instance, the five-month feeding period ending in June 1980 (which began in January 1980) overlaps with the four previous feeding periods ending in February, March, April, and May 1980. The four-period overlap causes autocorrelation in the regression residuals for up to four lags. In addition, economic factors that affect cattle feeding returns can cause autocorrelation in the regression residuals. The autocorrelation and partial autocorrelation functions for the OLS residuals from equation (1) indicated that a third-order autoregressive model was appropriate for the residual series.

A Cochrane-Orcutt procedure was used to estimate equation (1) with a third-order autoregressive model for the error term.[2] The regression results are shown in Table 2. The $\hat{\beta}$-value measures the systematic risk in a custom cattle feeding investment. For both steers and heifers, the $\hat{\beta}$-values are close to zero and not significant at the .05 level. This indicates that there is virtually zero systematic risk in custom cattle feeding, which is

[2]Equation (1) was estimated with 11 monthly intercept and 11 monthly slope shifter variables to allow the intercept and slope to vary by month. An F-test at the .05 level of significance failed to reject the null hypothesis that the intercept and slope shifter variables were all equal to zero.

consistent with the results from previous studies of agricultural assets (Dusak; Baxter, Conine, and Tamarkin; Elam and Vaught; Arthur, Carter, and Abizadeh; Barry; Irwin, Forster, and Sherrick).

The $\hat{\alpha}$-value in equation (1) is interpreted as excess percentage returns for a five-month period. For heifers, the $\hat{\alpha}$-value is .042 which is an excess return of 4.2% for a five-month feeding period. On an annual basis, the excess return is 10.1% ((12/5) * 4.2) for heifers and 4.1% for steers. The excess return for steers is not statistically significant, however. The excess return is higher for heifers than for steers, possibly because there is less interest (competition) in feeding heifers.

The results indicate that cattle feeding returns are typical of those from other low-beta assets in that they tend to be higher than the theoretical required rate of excess return (which is approximately 0). This particular result should not be unexpected given the current body of research on risk-return characteristics of agricultural assets. A research question of greater relevance would be a comparison of the risk-return characteristics of custom cattle feeding returns with low-beta securities. The research of Bjornson and Innes provides a method of analyzing this question. To determine the predicted rate of return for an asset based on the CAPM relationship, Bjornson and Innes estimate an empirical security market line (SML): $R_i = 0.00099 + 0.00032\ \hat{\beta}_i$, where R_i = excess return on asset i and $\hat{\beta}_i$ is the systematic risk for asset i. This equation applies to monthly returns. If the CAPM holds, the empirical SML equation can be used to estimate monthly excess rates of return for both non-agricultural and agricultural assets. It is obvious that the required return rate for a zero-beta asset, based on the <u>empirical</u> SML, is higher than the <u>theoretical</u> expected rate of 0% due to the presence of a positive intercept.

The empirical SML equation can be used to estimate the required rate of return for a cattle feeding investment, assuming the capital pricing relationship holds. First substitute the empirical betas for steer (.002) and heifer (-.048) feeding from Table 2 into the SML equation and solve for the excess return.[3] The result for both steers and heifers is a required rate of excess return of approximately 0.1% per month, or 1.2% on an annual basis. This rate should be compared to the estimated excess rates of return earned from feeding cattle in the Texas-Oklahoma Panhandle from 1980-1992 of 10.1% for heifers and 4.1% for steers on an annual basis. This comparison points out that a cattle feeding investment earns an excess return even higher than that earned by comparable risk non-agricultural assets such as stocks.

---

[3]The Bjornson and Innes estimates were obtained over a different time period (1963-1984). The authors recognize that a more appropriate comparison would involve the same time periods. Such a comparison, however, is left as a topic for further research.

Possible explanations for the excess returns include market inefficiency, illiquidity, and high transactions cost. One source of inefficiency could be the absence of perfect information. Relatively few investors consider investing in cattle feeding compared to investing in stocks, bonds, etc. A possible reason may be lack of awareness among investors concerning the expected returns from cattle feeding. There has only been one other recent study which examined the investment potential of custom cattle feeding (Miller). Because of the lack of information, there is less competition in cattle feeding, resulting in excess returns. Other sources of market inefficiency which could result in excess returns include under pricing of feeder cattle.

A second possible explanation for excess returns is illiquidity. A cattle feeding investment must be made for a minimum period (typically five months), and once cattle are put in a feedlot, the investment can only be liquidated by selling one's ownership in the cattle to another investor. This cannot be easily accomplished because a market does not exist for pre-finished cattle.

Because of its specialized nature, cattle feeding includes high transactions and search costs. To invest in feeding cattle, an investor must arrange for feeder cattle to be purchased and transported to a feedlot. Often money is borrowed to purchase the feeder animal and to cover the feeding cost, and this requires a financial arrangement with a bank for a loan. During the feeding period, the investor must monitor the feeding process to make certain that his cattle are being fed properly. This involves keeping abreast of the weather situation, studying daily feeding performance data for his cattle, comparing feeding performance data for different feedlots, etc. The cost in terms of time and money to monitor a cattle feeding investment is much higher than that for investing in stocks and bonds.

Arbitrage Pricing Theory

Arbitrage Pricing Theory (APT) is a multi-factor approach to estimating risk-return levels for assets. In contrast to the CAPM --which uses only one factor to explain asset returns--APT uses several factors (which could include the market factor from the CAPM). An abbreviated explanation of APT is provided in Ross, Westerfield, and Jaffe (chp. 10). The multi-factor version of APT assumes a linear relation between expected return and systematic risk:

$$(3) \quad E(R_i) = R_F + \lambda_1 \beta_{i1} + \ldots + \lambda_k \beta_{ik},$$

where λ_k is the risk premium for the kth systematic risk factor, and β_{ik} is the sensitivity of asset i's return to risk factor k. As defined above, the variables R_i and R_F are the return on asset i and the risk-free rate, respectively. The value for λ_k represents the price of risk (i.e., risk premium) for the kth economic risk factor. The λ's are not specific to a particular asset, but are market-wide risk premiums used in pricing of all types of assets (including stocks, bonds, futures assets, etc.). Previous studies have developed estimates of the λ's in equation (3) (e.g., Chen, Roll, and Ross; Bessembinder).

In empirical applications of the APT model, the β's are measures of the systematic risk of an asset to specific economic factors. The β's are estimated from a linear regression of the excess return for an asset on a specified set of economic risk factors. Financial economists have identified five economic factors important in explaining asset returns (Chen, Roll, and Ross). The economic factors are unanticipated industrial production (UIP); change in expected inflation (DEI); unanticipated inflation (UI); unanticipated change in risk premium (URP); and unanticipated change in the term structure (UTS). Detailed definitions of the variables are provided in Appendix Table A1. The systematic risk levels for a cattle feeding investment can be determined from the following regression:

$$(4)\ R_{it} - R_{Ft} = \beta_{io} + \beta_{i1}UIP_t + \beta_{i2}DEI_t + \beta_{i3}UI_t + \beta_{i4}URP_t + \beta_{i5}UTS_t + e_{it}.$$

In applying the CAPM to the series of cattle feeding returns, we failed to reject the null hypothesis that β_i=0 in equation 2. Thus, the conclusion from the CAPM analysis was that a cattle feeding investment has zero systematic risk. If this conclusion holds for APT, the slope coefficients in equation (4) will all jointly equal zero. As in the theoretical CAPM, in APT the expected return on a zero-risk investment is the risk-free rate, R_F. Thus, for a cattle feeding investment, the expected value of β_{io} is zero in equation (4), and a positive value for β_{io} implies that cattle feeders are receiving returns in excess of that required to compensate for the systematic risk.

Data on cattle feeding returns and the five economic risk factors were used to estimate equation (4) for the period 1980-1992. Total observations equal 156. A Cochrane-Orcutt procedure was used to estimate equation (4) (with a third-order error term) to correct for autocorrelation due to overlap in the five-month feeding periods (discussed above). The regression results for equation (4) are shown in Table 3, part A. The estimated slope coefficients are not significantly different from zero at the .05 level, indicating no significant sensitivity of cattle feeding returns to changes in the economic factors. An F-test does not reject the null hypothesis that all slope coefficients are jointly equal to zero. This provides support for the null hypothesis of zero systematic risk in a cattle feeding investment (which is the same conclusion reached based on the CAPM results in Table 2). Practically, the results indicate that cattle feeding is a low-risk investment which can be used to diversify a financial asset portfolio and reduce return variance for the portfolio. This evidence is consistent with other studies which show that a live cattle futures investment (as compared to physical cattle) has low systematic risk (Elam and Njukia; Bessembinder; Elam and Vaught).

The constant in equation (4) is interpreted as the five-month excess percentage return on a cattle feeding investment (above the required rate of R_F). For heifers, the constant is .039, which is an excess return of 3.9% for a five-month feeding period. This is comparable to the excess return of 4.2% from the CAPM results in Table 2. The excess return for steers is 1.5% for the APT results in Table 3 compared with 1.7% for the CAPM.

Parts B, C, and D of Table 3 report results of including additional economic variables in equation (4) beyond the five variables in part A. These variables come from Chen, Roll, and Ross, and include the excess return on the Standard and Poor's 500 Index (or market factor), the change in real per capita consumption expenditure on non-durable goods and services (CG), and the change in real crude oil price (OG). The market factor (MKT) is included because of its role in the CAPM. The importance of CG in explaining asset returns is derived from the Consumption CAPM, which relates asset returns to consumption expenditures (Breeden). In this model, unanticipated changes in consumption expenditures are measures of changes in wealth. Consumers express increased wealth through higher expenditures. Of the variables MKT, CG, and OG, only CG is significant in explaining heifer feeding returns (Table 3, part C). The negative sign for heifers suggests that cattle feeding may offer some protection to investors against unexpected economic downturns.

Summary and Implications

The risk-return characteristics of custom cattle feeding were analyzed over the 1980-1992 period using both CAPM and APT frameworks. The results indicated that neither the returns received from steers nor heifers contributed any systematic risk to a well-diversified portfolio. Historical returns received by custom cattle feeders, however, have been in excess of the rate required to compensate for any systematic risk, and above the rate for comparable risk non-agricultural assets. In fact, annual returns from feeding cattle have exceeded annual returns from more risky investments such as stocks and bonds.

The implication of excess returns is that investors require compensation for illiquidity, and/or high transactions costs. If feedyard managers are to attract custom feeders, they must give attention to reduction of illiquidity and transactions costs. For example, illiquidity could be reduced by encouraging the development of large limited partnerships for feeding cattle. Large limited partnerships could also reduce transactions costs through hiring representatives to buy feeder cattle and oversee the feeding operation. Feedyard managers could also encourage custom feeding by reducing any inefficiencies. If feeder cattle are underpriced, feedyard managers could encourage custom feeding by cow-calf producers who, in turn, could increase their returns per head. Information inefficiencies can be reduced by publicly releasing not only feedyard performance data but also net returns received by custom feeders.

References

Arthur, Louise M., Colin A. Carter, and Fay Abizadeh. "Arbitrage Pricing, Capital Asset Pricing, and Agricultural Assets." Amer. J. of Agr. Econ., 68 (1988): 359-367.

Barry, P. J. "Capital Asset Pricing and Farm Real Estate." Amer. J. of Agr. Econ., 62(1980): 549-53.

Baxter, J., Conine, T.E. Jr., and Tamarkin M. "On Commodity Risk Premiums: Additional Evidence." The Journal of Futures Markets, 5(1985): 121-25.

Bessembinder, Hendrik. "Systematic Risk, Hedging Pressure, and Risk Premiums in Futures Markets." The Review of Financial Studies, 5(1992): 637-667.

Bjornson, Bruce, and Robert Innes. "Another Look at Returns to Agricultural and Nonagricultural Assets." Amer. J. of Agr. Econ., 74(1992): 109-119.

Black, Fischer. "The Pricing of Commodity Contracts." Journal of Financial Economics, 3(1976): 167-79.

Breeden, Douglas. "An Intertemporal Asset Pricing Model with Stochastic Consumption and Investment Opportunities." J. of Financial Economics, 7(1979): 256-296.

Cattle-Fax. "Cattle-Fax Update." Cattle-Fax Resources, Inc., Englewood, CO, Feb. 23, 1990.

Chen, Nai-Fu, Richard Roll, and Stephen Ross. "Economic Forces and the Stock Market." J. of Business, 59(1986): 383-403.

Collins, Robert A. "The Required Rate of Return for Publicly Held Agricultural Equity: An Arbitrage Pricing Theory Approach." Western J. of Agr. Econ., 13 (1988): 162-168.

Dodson, Charles, and Emmett Elam. "Returns to Custom Cattle Feeding." J. of Agribusiness, 10:(1992): 3-18.

Dusak, K. "Futures Trading and Investor Returns: An Investigation of Commodity Market Risk Premiums." Journal of Political Economy, 8 (1973): 1387-1406.

Elam, E.W., and Daniel Vaught. "Risk and Return in Cattle and Hog Futures." J. of Futures Markets, 8(1988): 79-87.

Elam, Emmett, and Stephen Njukia. "The Risk Premium in Live Cattle Futures." Proceedings of NCR-134 Conference, Applied Commodity Price Analysis, Forecasting, and Market Risk Management, Chicago, IL, April 19-20, 1993, pp. 315-333.

Feedstuffs. The Miller Publishing Co., Minnetonka, MN, various issues.

Ibbotson Associates. Stocks, Bonds, Bills, and Inflation 1993 Yearbook. Ibbotson Associates, Inc., Chicago, IL., 1993.

Irwin, Scott H., Forster, D. Lynn, and Bruce Sherrick. "Returns to Farm Real Estate Revisited." Amer. J. of Agr. Econ., 70(1988): 580-87.

Jensen, M.C. "Capital Markets, Theory and Evidence." Bell Journal of Economics and Management Science, (1972): 357-398.

Kay, Steve. "Feedlots Gear Up for the '90s." Beef Today, June-July 1992, pp. Feedlot-5 and Feedlot-8.

Langemeier, Michael, Ted Schroeder, and James Mintert. "Determinants of Cattle Feeding Profitability." Southern J. of Agr. Econ., 24(1992): 41-47.

Miller, Jerry. "East Meets West." In Cattle Feeders Annual. Texas Cattle Feeders Association, Amarillo, TX, 1991, pp. 20-21.

Roll, R. "A Critique of the Capital Asset Pricing Theory's Tests." Journal of Financial Economics, 4(1977): 129-176.

Ross, Stephen, R.W. Westerfield, and Jeffrey Jaffe. Corporate Finance (2nd ed.). Richard D. Irwin, Inc., Homewood, IL, 1990.

Trapp, James N. "Seasonal Aspect of Cattle Feeding Profits." Current Farm Economics, 62,4(1989): 19-30.

U.S. Dept. of Agriculture, Market News Service, AMS. Livestock, Meat, and Wool Market News. U.S. Government Printing Office, Washington, D.C., various issues.

Appendix--Economic Factors for APT

Definitions of the economic factors used in the APT analysis are provided below. The basic series are monthly observations of the variables, and the derived series are for the usual five-month feeding period that cattle are fed.

Table A1. Definitions of APT Economic Variables.

A. Basic Series (monthly observations):

Symbol	Variable and Source
IP	Industrial production, not seas. adj. (*Survey of Current Business*, SCB)
CPI	Consumer Price Index for All Urban Consumers, CPI-U (SCB)
OIL	Producer Price Index, Crude Petroleum, 1982=100 (SCB)
CONS	Real per capita consumption expenditures for nondurable goods plus services, 1987=100 (SCB)
POP	U.S. resident population, first-of-the-month ("Current Population Reports: Population Est. and Proj.," P25-1114, March 1994, Bureau of the Census)
r_C	Total return on Aaa long-term corporate bonds (Ibbotson Assoc.)
r_G	Total return on long-term government bonds (Ibbotson Assoc.)
r_F	Total return on one-month Treasury bills (Ibbotson Assoc.)
r_M	Total return on Standard and Poor's 500 Index of stocks (Ibbotson Assoc.)

B. Derived Series (five-month period):

Symbol	Variable	Definition
OG_t a/	Growth in oil price	$\log_e(OIL_{t+1})-\log_e(OIL_{t-4})$
OC_t a/	Growth in consumption	$\log_e(CONS_{t+1}/POP_{t+1})-\log_e(CONS_{t-4}/POP_{t-4})$
UIP_t a/	Unanticipated indus. prod.	$\log_e(IP_{t+1})-\log_e(IP_{t-4})$
I	Inflation	$\log_e(CPI_t)-\log_e(CPI_{t-5})$
$E(I_t\|t-1)$ b/	Expected inflation, one-month ahead	Based on "naive interest rate model" of Fama and Gibbons.
$E(I_t\|t-5)$	Expected inflation over the five-month period t-5 to t	$E(I_t\|t-1)*5$ c/
DEI_t	Change in expected inflation	$E(I_{t+5}\|t) - E(I_t\|t-5)$
UI_t	Unanticipated inflation	$I_t - E(I_t\|t-5)$
Aaa_t	Compound return on Aaa long-term corporate bonds	$(1+r_{c,t})(1+r_{c,t-1})(1+r_{c,t-2})(1+r_{c,t-3})(1+r_{c,t-4}) -1.$

Table A1--continued

Symbol	Variable	Definition
LGT_t	Compound return on long-term government bonds	$(1+r_{G,t})(1+r_{G,t-1})(1+r_{G,t-2})(1+r_{G,t-3})(1+r_{G,t-4})$ -1.
URP_t	Unanticipated change in risk premium	Aaa - LGT
TB_t	Compound return on Treasury bills	$(1+r_{F,t})(1+r_{F,t-1})(1+r_{F,t-2})(1+r_{F,t-3})(1+r_{F,t-4})$ -1.
UTS_t	Unanticipated change in term structure	LGT - TB
$SP500_t$	Compound return on Standard and Poor's 500 Index of stocks	$(1+r_{M,t})(1+r_{M,t-1})(1+r_{M,t-2})(1+r_{M,t-3})(1+r_{M,t-4})$ -1.
MKT_t d/	Market factor	SP500 - TB

a/ The variables OG, OC, and UIP were shifted forward one period to make them contemporaneous with the other APT economic variables (as suggested by Chen, Roll, and Ross).

b/ $E(I_t|t-1)$ denotes the expected inflation for month t based on the information set available at the end of month t-1.

c/ This is a similar procedure to that used by Fama and Gibbons for their 8- and 14-month inflation projections.

d/ MKT = $(r_M - r_F)$, which is the market risk premium in the CAPM (equation (2) in the text).

Table 1. Average Annual Returns for Cattle Feeding and Various Alternative Investments, 1980-1992.

Investment	Annual Return (percent)
Standard and Poor's 500 Index	17.7
Small Stock	17.1
Long-Term Gov. Bond	13.1
Long-Term Corp. Bond (Aaa)	13.5
Treasury Bill	8.1
Dow Jones Futures	- 2.8
Dow Jones Spot	- 2.4
Heifers	18.4
Steers	13.0

Note: Stock and bond returns are from Ibbotson Associates. Dow Jones Futures and Spot index values are from the Wall Street Journal.

Table 2. Regression Results for Equation (2) for Steers and Heifers, 1980-1992.

Sex	Intercept, $\hat{\alpha}$	Slope, $\hat{\beta}$
Heifers	.042* a/	-.048
	(2.47)	(-.52)
Steers	.017	.002
	(1.02)	(.02)

Note: A total of n=156 observations was used in estimation. Each equation was corrected for third-order autocorrelation using a Cochrane-Orcutt procedure.

a/ t-statistics are shown in parentheses.

* Significantly different from zero at .05 level for a two-tail test.

Table 3. Economic Variables and Custom Cattle Feeding Returns for Steers and Heifers, 1980-1992.

A. Arbitrage Pricing (AP) Variables from Chen, Roll, and Ross:

Sex	Constant	UIP	DEI	UI	URP	UTS		F a/
Heifers	.039*	.176	-.0002	1.292	.338	-.012		1.25
	(2.48) b/	(.85)	(-1.16)	(1.45)	(.97)	(-.09)		
Steers	.015	.059	-.0001	.765	.590	.146		1.10
	(.94)	(.30)	(-.93)	(.88)	(1.75)	(1.20)		

B. AP Variables Plus Market Factor:

Sex	Constant	UIP	DEI	UI	URP	UTS	MKT	F
Heifers	.040*	.203	-.0002	1.309	.336	.012	-.048	1.09
	(2.56)	(.96)	(-1.13)	(1.47)	(.96)	(.09)	(-.48)	
Steers	.015	.069	-.0001	.770	.588	.154	-.018	.92
	(.96)	(.34)	(-.92)	(.88)	(1.74)	(1.19)	(-.19)	

C. AP Variables Plus Consumption:

Sex	Constant	UIP	DEI	UI	URP	UTS	CG	F
Heifers	.052*	.258	-.0002	1.554	.343	.058	-2.725*	1.80
	(2.96)	(1.26)	(-1.11)	(1.74)	(1.00)	(.45)	(-2.20)	
Steers	.023	.109	-.0001	.928	.604	.193	-1.672	1.24
	(1.33)	(.55)	(-.89)	(1.05)	(1.80)	(1.54)	(-1.40)	

D. AP Variables Plus Oil Price:

Sex	Constant	UIP	DEI	UI	URP	UTS	OG	F
Heifers	.039*	.179	-.0002	1.273	.337	.016	.046	1.18
	(2.45)	(.87)	(-1.16)	(1.43)	(.97)	(.13)	(.86)	
Steers	.014	.066	-.0001	.749	.593	.179	.058	1.13
	(.91)	(.34)	(-.95)	(.86)	(1.76)	(1.43)	(1.10)	

Note: UIP = unanticipated industrial production; DEI = change in expected inflation; UI = unanticipated inflation; URP = unanticipated change in the risk premium (Aaa long-term corporate bond return - long-term government bond return); UTS = unanticipated change in the term structure (long-term government bond return - Treasury-bill rate); MKT = return on the S&P 500 Index (incl. capital appreciation plus dividends); CG = growth rate in real per capita consumption expenditures (nondurable goods plus services); OG = growth rate in oil prices. A total of n=156 observations was used in estimation. Each equation was corrected for third-order autocorrelation using a Cochrane-Orcutt procedure.

a/ F-statistic for the hypothesis that all slope coefficients are jointly equal to zero. None of the F-statistics are significant.

b/ t-statistics are shown in parentheses. An asterisk (*) indicates the estimated coefficient is significantly different from zero at .05 level for a two-tail test.