The Required Rate of Return for Publicly Held Agricultural Equity: An Arbitrage Pricing Theory Approach

Robert A. Collins

Recent interest in equity financing for commercial agriculture has created the need to reexamine the required rate of return for agricultural equity. The required rates of return for ten publicly held firms with agricultural operations are examined with arbitrage pricing theory. The results suggest that the required rate of return for this group of firms is similar to the required rate of return for an average share of stock.

Key words: arbitrage pricing theory, cost of capital, equity financing.

The well-documented growth in farm size and associated increases in capital intensity over the last thirty-five years have created difficult financing demands for the U.S. agricultural sector. The growth in real assets has exceeded the rate at which equity could be generated within the sector, resulting in increases in debt financing.1 This secular trend has created interest in mechanisms for attracting external equity into the farm sector (Boehlje; Fiske, Batte, and Lee; Collins and Bourn; Moore; Penson) to give production agriculture a choice between debt and equity financing. Several institutional structures that would allow a proprietary farm to gain access to Wall Street equity have been proposed. One proposal (Collins and Bourn) suggests that a publicly traded real estate investment trust (REIT) could form limited partnership agreements with individual commercial farms. If the REIT provided a certain amount of financing in exchange for a share of the farm’s income, a formal financial intermediary would exist to channel equity financing from Wall Street to commercial farms. A mechanism allowing a proprietary farm to attract outside equity financing could allow for orderly firm growth with less financial risk and thus less turmoil in future difficult times. The rate of return that investors would require to provide equity financing to agriculture depends on the risks associated with agricultural investments and how these risks affect the risk of a well-diversified portfolio. This study briefly evaluates previous studies of the required rate of return for agricultural investments and estimates the required rate of return for ten publicly held firms with arbitrage pricing theory (APT).

The first attempt to evaluate the required rate of return for an agricultural investment was Barry’s pioneering capital-asset-pricing-model (CAPM) study of farmland. He regressed the earnings and capital gains from farmland on an index and found very little systematic risk. From this, he concluded that the required rate of return to hold farmland in a well-diversified portfolio is only slightly above the riskless rate. He cautioned, however, that the thin markets for land and the illiquidity of the investment could cause the required rate of return to be higher than what the CAPM suggested.

The problem of estimating a liquidity premium is substantial. Even though economic theory suggests that a premium for both illiquidity and systematic risk should exist, the measurement of liquidity and the associated premium is generally neglected in the literature. Since the market models (CAPM, APT)

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1 Some of the secular increase in the use of debt undoubtedly reflects the choice to borrow more and reinvest less rather than the sheer force of expansion. These choices may have been affected by a general change in attitudes toward debt as well as by incentives of government agricultural policy (see Gabriel and Baker, Collins).

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make no provision for illiquidity, the required rate of return for agricultural investments must be estimated from the behavior of agricultural investments that are liquid, that is, publicly traded.

The problem with this approach is that there are so few publicly traded agricultural investments that are available for evaluation. Additionally, the available sample is not a very representative cross section of American agriculture. This would tempt one to follow Barry's approach and evaluate aggregate agricultural income. However sensible this approach may appear, it neglects an important aspect of asset pricing. 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 occurs because the systematic effects in the capitalization of income by equity markets are ignored. This may be thought of as the systematic capital gains and losses caused by the changes in the average price-earnings ratio (P/E).

This problem may be demonstrated by examination of a broad-based market index like the Standard and Poors (S&P) 500 composite index. The returns to the index have by definition a systematic risk (β) of one. However, if income only is examined, a very different result obtains. This method was tested by regressing the average earnings per share for the S&P 500 stocks on the S&P 500 index. Earnings per share include recognized capital gain income and operating income. Results of this regression using quarterly data from 1975 through 1985 are shown in table 1. With an estimated β of 0.01, it is apparent that some systematic risk is being missed. The hypothesis test for H₀:β = 1 yields a t-value of -388.5. This creates substantial doubt that risk premia for equities may be reliably estimated from systematic variation in income alone. This occurs because the effects of systematic movements in the average P/E are not considered.

In addition, empirical applications of the CAPM have been criticized because empirical tests have produced results inconsistent with theory. There have been many of these studies, a few of which are Blume and Friend; Black, Jensen, and Scholes; Miller and Scholes; Blume and Husick; and Fama and Macbeth. Nearly all of the studies agree that the intercept of the security market line is greater than the riskless rate and that the slope is less than the market risk premium. Roll pointed out that previous tests of the CAPM were really tests of ex post mean-variance efficiency of the market index. He also raised serious questions about the potential for empirically testing the CAPM. All of this created support for APT, which is more general and apparently testable (see Dybvig and Ross, Shankin).

### Arbitrage Pricing Theory

The APT model requires no assumptions about the form of the distribution of the return to assets, and no specific form is required for investors' utility functions. The market portfolio is not required to be efficient and, indeed, is not considered. It allows multiple factors to influence asset returns as the multiple index CAPM does but focuses on unanticipated shifts in the factors. APT has also survived well from ten years of empirical scrutiny (Roll and Ross; Chen; Bower, Bower, and Logue) Comparisons with the CAPM generally favor APT, and evaluations of testing procedures have not established major flaws. (See Dhrymes, Friend, and Gultekin 1984 for a critical perspective.) As a result of these theoretical and empirical advantages, APT is emerging as a preferred model of asset pricing under risk.

The number of factors that may affect the

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**Table 1. Regression Model**

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t</th>
<th>H₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>α = 1.77</td>
<td>σₓ = 0.32836</td>
<td>t = 5.38</td>
<td>(H₀: α = 0)</td>
</tr>
<tr>
<td>β = 0.01</td>
<td>σᵧ = 0.00254</td>
<td>t = -388</td>
<td>(H₀: β = 1)</td>
</tr>
</tbody>
</table>

Note: $R^2 = .333.$
price of individual assets is very large. Most of these factors, however, are unique to particular firms or groups of firms, and their effects may be diversified away. Assuming these idiosyncratic effects can be eliminated by costless diversification, they will not affect the return required by investors. Factors that cause well-diversified portfolios to vary in value are called systematic factors and provide the basis for market risk premiums. It is assumed that investors incorporate expectations of shifts of the systematic factors into their expectations of each asset's return, and only the unanticipated changes in the systematic factors affect asset prices. Therefore, the basic assumption of APT may be stated as follows:

\[ \hat{R}_i = E(\hat{R}_i) + \beta_i^tF + \tilde{e}_i, \]

where \( \hat{F} \) is a random vector of systematic factors with zero means, \( \beta_i \) is a vector of sensitivity coefficients to the systematic factors for asset \( i \), \( \tilde{e}_i \) is the return to idiosyncratic factors for asset \( i \), \( E[\tilde{e}] = 0 \), \( E \) is the expectations operator, and the random rate of return to asset \( i \) is \( (\hat{R}_i) \).

It is presumed that self-interested, risk-averse investors will be constantly vigilant for opportunities to improve their risk-return position by revising their portfolios or by forming "arbitrage portfolios." (A clear and simple explanation of this process may be found in Roll and Ross 1984.) Assets with high expected returns relative to their systematic risk will be bought, driving their price up and expected return down, and the opposite will occur for "overpriced" stocks. Assuming that investors are greedy and risk averse and that arbitrage portfolios having no risk and requiring no wealth can earn no return,2 Ross shows that in equilibrium the expected (and required) return on asset \( i \) will be

\[ E(\hat{R}_i) = R_f + \lambda \beta_i, \]

where \( \lambda \) is a vector of market "prices" of risk associated with the systematic factors.

The primary weakness of the model is that it is not clear what the relevant, i.e., priced, factors are. Roll and Ross (1980) and Chen, Roll, and Ross suggest that the real economic factors that are priced include unanticipated changes in (a) inflation, (b) industrial production, (c) risk premiums, and (d) the slope of the yield curve. Because of the obvious data problems of observing unanticipated shifts, empirical APT studies continue to use factor analysis to estimate the factors. Following Roll and Ross (1980) and Bower, Bower, and Logue (1982, 1984), this study uses a four-factor model. The factor analysis model produces a set of four orthogonal factor scores that best explain security returns.

### Estimation of APT Parameters

The data used to estimate the factor analysis model were daily returns from all stocks continuously listed on the New York and American stock exchanges in the period 1 January 1978 through 31 December 1984. These firms and their primary products are shown in table 2. The daily returns data were collected for the 1,771 stocks meeting this sample criterion from the Center for Research in Security Prices (CRSP) tape. Monthly returns were calculated for each stock by finding the geometric mean of the daily returns. To reduce noise, the 1,761 nonagricultural stocks were grouped into 57 equally weighted portfolios of about 30 stocks each from similar industries.3 The 84 monthly observations of the 57 portfolios were then factor analyzed with a four-factor iterated

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2 Other assumptions require the usual conditions of homogenous beliefs and frictionless markets along with bounded expectations and the existence of a type-B agent with nonnegligible wealth.

3 This procedure and other estimation practices are carefully evaluated in Bower, Bower, and Logue (1982).
Table 3. Estimated APT Reaction Coefficients for Ten Publicly Held Agricultural Firms

<table>
<thead>
<tr>
<th>Firm</th>
<th>$\hat{\beta}_1$</th>
<th>$\hat{\beta}_2$</th>
<th>$\hat{\beta}_3$</th>
<th>$\hat{\beta}_4$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cagles, Inc.</td>
<td>0.0296*</td>
<td>-0.0460*</td>
<td>-0.0300*</td>
<td>0.0283*</td>
<td>.17</td>
</tr>
<tr>
<td>Castle and Cooke, Inc.</td>
<td>0.0479*</td>
<td>-0.0006</td>
<td>0.0062</td>
<td>0.0147*</td>
<td>.33</td>
</tr>
<tr>
<td>Friona Ind., Inc.</td>
<td>0.0488*</td>
<td>-0.0006</td>
<td>-0.0023</td>
<td>0.0039</td>
<td>.22</td>
</tr>
<tr>
<td>Katy Ind., Inc.</td>
<td>0.0813*</td>
<td>-0.0251*</td>
<td>0.0068</td>
<td>0.0097</td>
<td>.41</td>
</tr>
<tr>
<td>Newhall Land and Farming</td>
<td>0.0583*</td>
<td>-0.0114</td>
<td>0.0100</td>
<td>-0.0082</td>
<td>.31</td>
</tr>
<tr>
<td>Orange-Co., Inc.</td>
<td>0.0445*</td>
<td>0.0226*</td>
<td>0.0084</td>
<td>0.0005</td>
<td>.13</td>
</tr>
<tr>
<td>San Carlos, Inc.</td>
<td>0.0836*</td>
<td>-0.0199</td>
<td>0.0520*</td>
<td>0.0579*</td>
<td>.30</td>
</tr>
<tr>
<td>Southeastern Public Service</td>
<td>0.0183*</td>
<td>-0.0118</td>
<td>0.0105</td>
<td>0.0053</td>
<td>.07</td>
</tr>
<tr>
<td>Sun City Ind., Inc.</td>
<td>0.0638*</td>
<td>-0.0132</td>
<td>-0.0083</td>
<td>0.0116</td>
<td>.29</td>
</tr>
<tr>
<td>Tejon Ranch Co.</td>
<td>0.0653*</td>
<td>-0.0016</td>
<td>0.0389*</td>
<td>-0.0118</td>
<td>.24</td>
</tr>
</tbody>
</table>

Note: Asterisk indicates significant at 10% level.

principal factor analysis model. The factor scores fit the data well, with an average communality coefficient of 0.868 over the 57 portfolios. The APT coefficients were estimated in the standard fashion (Bower, Bower, and Logue 1982, 1984) from these four common factors:

$$\delta_{1t}, \ldots, \delta_{4t}, \quad t = 1, \ldots, 84.$$  

First, the sensitivity of each of the fifty-seven portfolios to the common factors was estimated with time-series regressions. Each portfolio’s return ($R_{it}$) was regressed on the factor scores ($\delta_{1t}, \ldots, \delta_{4t}$) from the factor analysis (57 regressions, 84 observations each):

$$R_{it} = \beta_{10} + \beta_{11}\delta_{1t} + \ldots + \beta_{44}\delta_{4t} + \epsilon_{it}, \quad t = 1, \ldots, 84.$$  

The estimated values of the beta coefficients in equation (3) were then used to estimate the lambda coefficients in equation (2) with cross-sectional regressions. The portfolio returns for each month were regressed on their estimated betas from the time-series regressions (84 regressions, 57 observations each):

$$R_{it} = \lambda_{10} + \lambda_{11}\beta_{11} + \ldots + \lambda_{44}\beta_{44} + \eta_{it}, \quad t = 1, \ldots, 84.$$  

The lambda-s are the marginal effect of the betas on the required return of the portfolio, and $\eta$ is the error term.

The average value of each of the lambda parameters over the eighty-four regressions was used as the value for the APT model. The annualized estimated APT equation for the market model was

$$E(r) = 0.0557 + 2.998\hat{\beta}_1 + 1.271\hat{\beta}_2 - 1.268\hat{\beta}_3 - 0.448\hat{\beta}_4.$$  

Estimates of the required rate of return for the ten agricultural firms required estimating their reaction coefficients. The APT coefficients were estimated by regressing the returns from each of the ten agricultural firms ($A_{jt}$) on the factor scores:

$$A_{jt} = \beta_{10} + \beta_{11}\delta_{1t} + \beta_{22}\delta_{2t} + \beta_{33}\delta_{3t} + \beta_{44}\delta_{4t} + \gamma_{jt}, \quad j = 1, \ldots, 10.$$  

The results of these equations are shown in table 3.

Estimates of the required rate of return for the ten agricultural firms are shown in table 4.

Table 4. Estimated Required Rates of Return for Ten Publicly Held Companies with Agricultural Assets

<table>
<thead>
<tr>
<th>Company</th>
<th>Required Return APT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cagles, Inc.</td>
<td>11.1</td>
</tr>
<tr>
<td>Castle and Cooke, Inc.</td>
<td>18.4</td>
</tr>
<tr>
<td>Friona Ind., Inc.</td>
<td>20.2</td>
</tr>
<tr>
<td>Katy Ind., Inc.</td>
<td>25.5</td>
</tr>
<tr>
<td>Newhall Land and Farming</td>
<td>20.7</td>
</tr>
<tr>
<td>Orange-Co., Inc.</td>
<td>20.7</td>
</tr>
<tr>
<td>San Carlos, Inc.</td>
<td>18.9</td>
</tr>
<tr>
<td>Southeastern Public Service</td>
<td>11.0</td>
</tr>
<tr>
<td>Sun City Ind., Inc.</td>
<td>23.5</td>
</tr>
<tr>
<td>Tejon Ranch Co.</td>
<td>20.5</td>
</tr>
<tr>
<td>Mean</td>
<td>19.05</td>
</tr>
</tbody>
</table>

This is the current state of the art in estimating APT models. See Roll and Ross (1980); Chen; and Bower, Bower, and Logue (1982, 1984).
4. Estimates of the required rate of return for each firm were derived by substituting estimated reaction coefficients from equation into market equation (5). These estimates are shown in table 4. The average required rate of return for the ten sample firms was 19.05%. The required rate of return for the average share over the sample period was slightly higher at 20.8%. It does not appear that the required return for the average of the firms is different in any important sense from all stocks. The APT estimates are higher than the CAPM estimates in Collins and Bourn because of differences in the riskless rate and the expected market return. In Collins and Bourn, estimates of current values were used. When estimates from the sample period are used, the average CAPM estimate for the ten firms is higher than the APT estimates at 21.25%. These estimates are much higher than Barry’s estimates for farmland because systematic risk from changes in the P/E ratio are considered. Presumably, equity interests in illiquid agricultural assets with the same systematic risks would be higher because of the liquidity premium.

Summary and Conclusions

This paper estimates with arbitrage pricing theory the return investors require to hold publicly traded equity investments in ten agricultural firms and compares these estimates to conventional capital-asset-pricing-model estimates. The model indicates a much higher required rate of return than previously estimated with annual data for farmland, but APT estimates are slightly lower than CAPM estimates for publicly held agricultural stocks. Based on the small number of firms available for study, there is no compelling reason to believe that the required rate of return for publicly traded agricultural equities is any different than for other publicly traded equity investments. This suggests that the investment community regards the effect of agricultural investments on the riskiness of a well-diversified portfolio to be neither excessive nor minimal and stands ready to provide equity capital for agriculture if provided reasonable terms and a viable institutional structure. Given that investors’ requirements are accurately reflected by this small sample of firms and the prevailing rates of return to equity in commercial agriculture, the average farm could not sell equity at par to an agricultural equity pool unless investors expected substantial capital gains. It appears that investors might be interested only in the small proportion of commercial farms that are very well managed and highly successful.

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References


