# Returns to Capital in Agriculture:

# A Historical View

# Using Portfolio Theory



by

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## Abstract

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Returns from various U.S. capital assets are used to construct efficient investment portfolios for four time periods in the post-WWII era. These efficient portfolios show a higher proportion of farm real estate than are actually observed. Conclusions are that returns to farm real estate may have been high relative to their risk.

# Returns to Capital in Agriculture:
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A number of scholars purport that returns in agriculture are persistently low. The problem is attributed to asset fixity (Johnson and Quance), lack of market power (Tweeten), the technological treadmill (Cochran), and farmers' willingness to accept low returns (Brewster; Bullock). The purpose of this paper is to offer a contrary claim: when agriculture is viewed as part of the nation's wealth portfolio, returns to capital are not persistently low. In fact, aggregate returns may have been relatively high given the level of risk experienced by agriculture.

## Capital Asset Pricing Theory

We will assume owners of agricultural capital are utility maximizers in the Markowitz tradition. That is, they prefer assets with lower risk, for any given level of return. Individuals assemble investment portfolios that maximize utility, which is a function of returns and risk.

A necessary step in this maximization process is the construction of efficient portfolios that provide minimum risk for a given level of return. Conceptually, an efficient set of portfolios or a "frontier" can be constructed, consisting of all portfolios that maximize returns for various levels of risk.

The capital asset pricing model (CAPM), developed by Sharpe and Lintner, concludes that capital assets are priced to fit in an equilibrium portfolio. Relying heavily on several key assumptions, CAPM states that there is one equilibrium portfolio on the frontier that exists for all investors. Assets are priced

so that they attain a place in this equilibrium portfolio.

Assets failing to appear in any portfolio along the frontier indicates inadequate returns, and prices of these assets would be reduced until returns, relative to asset prices, are more favorable. Conversely, assets appearing in relatively high proportions on the frontier would have "high" returns. That is, they would be favored by investors, and their prices would be expected to increase until returns, relative to asset prices, become more reasonable.

The previous discussion suggests the price of any capital asset is a function of expected annual returns, the covariance of these returns with other returns in the equilibrium portfolio, and the risk free interest rate. Thus, the contribution of an individual capital asset to the risk of this equilibrium portfolio is a critical element in asset pricing. Those assets with returns having the highest covariances with equilibrium portfolio returns will be priced to offer the highest rate of return. Similarly, those with little or no covariance with the market portfolio will be priced so that rates of return are relatively low, or close to the risk free interest rate. Using the CAPM, Barry concluded that farm real estate contributed little to the risk of the nation's wealth portfolio. Thus, in the equilibrium portfolio, farm real estate would be priced so that rates of return are near risk free interest rates.

The existence of one equilibrium portfolio depends on two key assumptions. First, the CAPM assumes a single risk free interest rate exists and is available to borrowers or lenders. Second, it assumes investors can borrow or lend any amount at the

risk free rate. Without these assumptions, a single equilibrium portfolio does not exist. Instead, many portfolios on the frontier might be used by investors.

Asset pricing may be consistent with discounting future returns by some "appropriate" discount rate. Most explanations of farm real estate prices, and implicitly the rate of return, use some variation of the standard discounting formula (Phipps; Castle and Hock; Melichar; Lee and Rask; Reinsel and Reinsel; Robison, et al.). However, the capital asset pricing literature implies that the "appropriate" discount rate is affected by return covariances as well as the risk free interest rate. White and Zlemir Zimmer empirically tested a model using this theoretical base and found it to be useful in explaining farm real estate pricing.

A problem in examining the implications of the capital asset pricing model is that estimation of the portfolio frontier is an ex ante concept. Yet return and risk estimates must rely on ex post measures of return and return variability. For this study, data from 1947-84 are used to estimate: (a) four efficient "investment portfolio frontiers," where each frontier is estimated using a twenty-three year time frame during the post WWII period; and (b) the combinations of capital assets in these alternative efficient investment portfolio frontiers, where each portfolio along the frontier may contain the range of U.S. capital assets.

Of special interest is the proportion of agricultural real estate in the efficient portfolios. Our contention is that returns to farm real estate would be "normal" if efficient investment portfolios consistently contain farm real estate in

approximately the same magnitude as does the actual U.S. investment portfolio for the same period. If efficient investment portfolio frontiers contain little farm real estate, then returns to farm real estate, and implicitly returns to agricultural capital, would appear to be "too low." In that case, the argument could be made that farm real estate returns were too low due to unique institutional or structural features such as those offered by Johnson and Quance, Cochrane, Tweeten, Brewster and Bullock. Conversely, if the proportion of farm real estate in efficient portfolios is consistently greater than that observed in the actual U.S. investment portfolio, then returns in agriculture would appear to be "too high."

Estimation of Efficient Investment Portfolios

Data used in the analysis are from Ibbotson, Siegel and Love and from Ibbotson and Fall. These sources estimate annual returns for a variety of investments including common stock (from NYSE, AMEX and OTC exchanges), fixed income corporate securities (preferred stock, long-term and intermediate-term corporate bonds, and commercial paper), real estate (farm and residential housing), U.S. government securities (agencies securities and Treasury bills, notes, and bonds), foreign equities, foreign bonds, metals and municipal bonds. Also, these sources estimate the average market value of each of these investments annually. Using the market value of these investments, an approximation of the composition of the actual U.S. investment portfolio can be estimated. As readily admitted by Ibbotson, et al., some investments are omitted from the estimates, e.g. the value of many small businesses, personal holdings, and human capital. Yet

the estimates do measure the value of investments most marketable, identifiable, and making up the opportunity set of most investors.

Annual returns are the sum of both changes in asset values and annual income in the form of dividends from equity instruments, interest from debt instruments, or rent from real estate. USDA is the source of all farm real estate data. Rent data and the aggregate value of farm real estate are from the "Balance Sheet of the Farming Sector." Capital gains data are from "Farm Real Estate Market Developments." For our analysis, annual returns of all investment instruments are deflated by changes in the GNP price deflator to arrive at an annual real rate of return for all investments (Table 1).

MOTAD (minimization of total absolute deviations) was chosen as the method to compute efficient investment portfolios. MOTAD can be used to select a portfolio that minimizes a measure of return variability, absolute value of negative return deviations, given a particular rate of return. Results are consistent with the EV frontier from quadratic programming (Thompson and Hazell). Examples of MOTAD applications in portfolio selection include Brink and McCarl and Schurle and Erven.

The model formulated for this analysis is the dual of the traditional MOTAD formulation. Investment portfolio returns are maximized subject to a constraint on the absolute value of the sum of negative deviations in portfolio returns over time. Mathematically, the problem can be expressed as the following:

$$(1)\quad \text{maximize} \quad \sum_{j=1}^{n} r(j)\, x(j)$$

subject to

$$(2)\quad \sum_{j=1}^{n} [c(h,j)-r(j)]\, x(j) + y(h) \geq 0$$

for $h=1,2,\ldots,s$;

$$(3)\quad \sum_{h=1}^{s} y(h) = D$$

for $D = 0$ to unbounded;

$$(4)\quad \sum_{j=1}^{n} x(j) = 1 \quad \text{and}$$

$$(5)\quad x(j),\ y(h) \geq 0$$

where $r(j)$ is the mean annual real rate of return for investment $j$ over $s$ years; $x(j)$ is the proportion of funds in investment $j$; $c(h,j)$ is the real rate of return for investment $j$ in year $h$; $n$ is the number of investment alternatives; $y(h)$ is the absolute value of the sum of the negative deviations in returns in year $h$; and $D$ is the total sum of negative deviations in returns over $s$ years.

The model measures risk as the sum of absolute value of the negative deviations in returns. This is equivalent to measuring risk as the standard deviation in returns as measured by the estimator, $d \cong s/(2(s-1)]^{\frac{1}{2}}$, where $d$ is the estimated mean absolute deviation in returns and $s$ is the number of years in the sample.

(Schurle and Erven) The estimated standard deviation is used in this analysis.

Time Periods Used in the Analysis

The period 1947-84 is divided into four time periods for this analysis: 1947-69, 1952-74, 1957-79, and 1962-84. Each of these four periods is used to construct an efficient U.S. investment portfolio frontier. That is, each 23 year period is assumed to provide sufficient ex post data to construct a series of efficient investment portfolios, with each portfolio consisting of combinations of 10 U.S. investments. The investments included in this analysis are common stocks, commercial paper, intermediate term corporate debt, long term corporate debt, farm real estate, residential housing, Treasury bills, Treasury notes, Treasury bonds, and U.S. government agency securities.

The proportion of farm real estate in the efficient portfolios is the primary concern of this research, but another point of interest is the stability of the frontiers. The first two periods, 1947-69 and 1952-74, witnessed relatively stable, but downward trending, real output prices. Overproduction was the perceived problem, government programs sought to idle cropland, farms were consolidated, and labor was moved out of farming. The periods 1957-79 and 1952-84 both contained the "scarcity" era of the 1970's when real output prices increased dramatically, and farmers rapidly increased production to meet growing export demand. The last period, 1969-84, contained the farm real estate price debacle of the 1980's as well as the 1970's price surges.

These four periods were chosen to represent a range of conditions over the post-WWII era and to incorporate equal time intervals in each period. Other time intervals might result in different frontiers than the ones presented here, but the four periods would seem to be as different from one another as any in the past half century.

Results

The actual average proportion of farm real estate in the U.S. investment portfolio for the four time periods is the following:

| Time Period | Proportion |
|---|---|
| 1947-69 | 12.2 percent |
| 1952-74 | 11.5 |
| 1957-79 | 11.4 |
| 1962-84 | 11.1 |

The range is 8.0 percent, occurring in 1984, to 14.8 percent, in 1952.

Results of our analysis are shown in Figure 1. In the top panel, the four frontiers are illustrated. They vary somewhat from one another with the 1947-69 portfolio being the most unique of the four. The performance of common stocks (high returns and high variability) causes the shape of the 1947-69 frontier to differ from the others. The bottom panel depicts the proportion of farm real estate in the efficient portfolios. This proportion is consistently larger than that in the actual U.S. investment portfolio. In three of the four periods (1952-74, 1957-79, and 1962-84), farm real estate provides the highest average annual return of any of the 10 investment alternatives. Thus, profit

maximizing portfolios contain all farm real estate for these three periods. But returns to farm real estate in these three periods are also relatively risky. As a result, most portfolios along the three frontiers combine farm real estate with common stocks, residential real estate, commercial paper, and other debt securities. However, a relatively high proportion of farm real estate is in portfolios all along the three frontiers. The minimum risk portfolios for all three periods contain some farm real estate.

In one period, 1947-69, common stocks have the highest average annual return. However, farm real estate performed nearly as well, and it is found in all efficient portfolios other than the profit maximizing one.

Implications

Efficient U.S. investment portfolios show higher proportions of farm real estate than are actually observed. Thus, from a capital asset pricing perspective, investors should have bid up the price of agricultural assets more rapidly than actually observed, and consequently, driven down later returns. Returns to farm real estate ownership are not low given their riskiness. Much of the agricultural policy discussion rests on the assumption that returns in agriculture are low, relative to other sectors. This analysis suggests the opposite, that returns have been high in relation to their risk over the post-WWII era.

These results may be somewhat distorted by the nature of the data being used. Risk in farm real estate returns may be understated since returns are computed as average annual returns to all U.S. farm real estate. However, most farm real estate is

owned by an individual in one particular geographic area. Returns in any particular geographic area are probably more variable than returns across the nation. Also, the procedure used to calculate capital gains in real estate may underestimated fluctuations in real estate prices. Since farm real estate price information lags actual transactions, reported prices tend to underestimate price changes. On the other hand, arguments can be made for actual returns to farm real estate being higher than reported data. The reported data use cash rents to estimate annual income, but cash rents offer a less risky income stream to farm real estate owners than do share rents or operating returns. Since risk is lower, reported cash rents may be lower than income from other tenure arrangements.

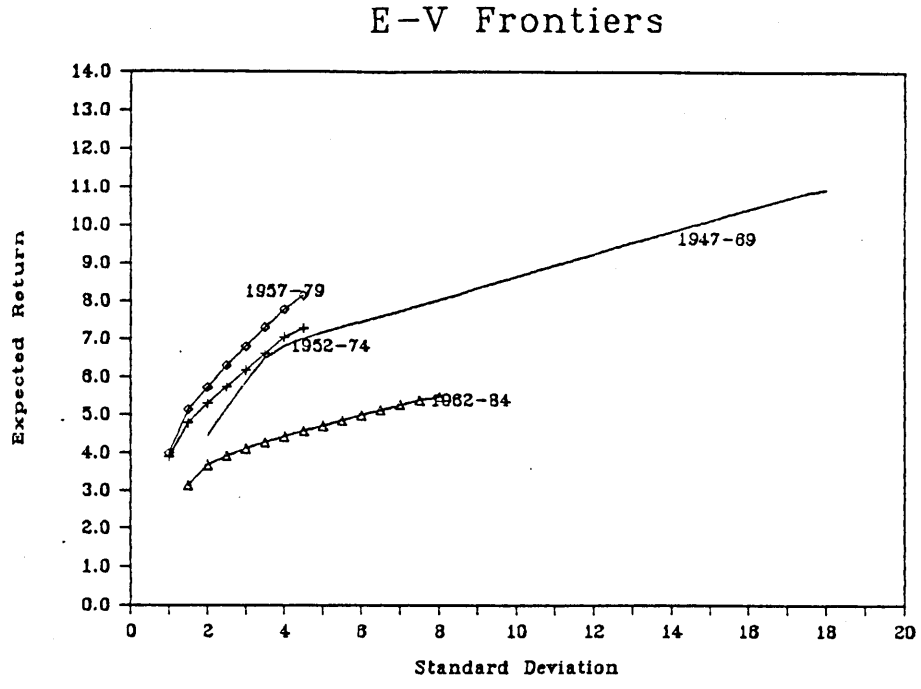
The divergence between actual holdings of farm real estate and the proportions in the estimated efficient frontiers may also be due to a lack of correspondence between the CAPM assumptions and the characteristics of investors and markets. Barry observed that farm real estate is a relatively illiquid asset due to high transaction costs, tax obligations, indivisibilities, and thin markets. Despite these obvious flaws, the CAPM provides a useful general equilibrium framework for examining the returns to farm assets. Our analysis suggests the conventional wisdom of "low returns" may not be well founded.

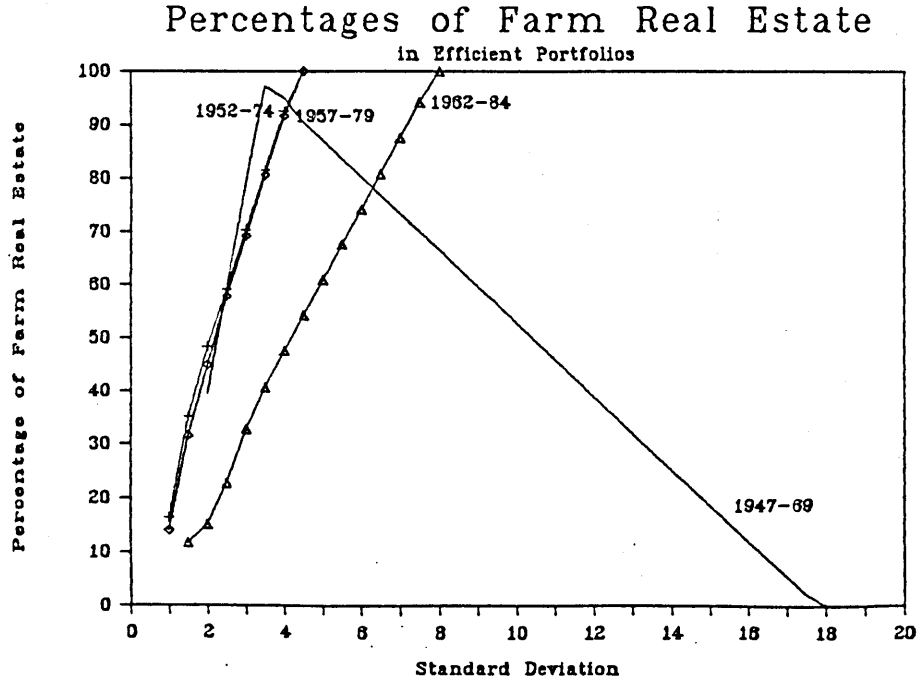
Table 1. Mean Annual Real Returns and Variabilities of Returns for Alternative U.S. Capital Assets, Four post-WWII Periods.

| | 1947-69 | | 1952-74 | | 1957-79 | | 1962-84 | |
|---|---|---|---|---|---|---|---|---|
| Asset | Mean | Stand. Dev. | Mean | Stand. Dev. | Mean | Stand. Dev. | Mean | Stand. Dev. |
| Farm Real Estate | 6.58 | 4.06 | 7.25 | 5.38 | 8.14 | 5.27 | 5.46 | 8.31 |
| Common Stocks | 10.92 | 17.26 | 7.21 | 19.82 | 5.30 | 18.15 | 4.09 | 16.36 |
| Corporate Debt | | | | | | | | |
| -Long Term | -1.94 | 6.55 | -1.32 | 6.42 | -1.14 | 7.79 | 0.02 | 11.70 |
| -Inter-mediate Term | -0.15 | 5.16 | 0.49 | 4.69 | 0.06 | 5.05 | 1.05 | 7.30 |
| -Commercial Paper | 0.53 | 3.45 | 1.60 | 0.98 | 1.12 | 1.45 | 1.70 | 2.14 |
| Housing | 3.05 | 2.09 | 3.45 | 1.22 | 3.75 | 1.53 | 3.45 | 2.41 |
| Treasury | | | | | | | | |
| -Bills | -0.12 | 3.41 | 0.80 | 1.17 | 0.36 | 1.46 | 0.97 | 2.25 |
| -Notes | -0.25 | 4.12 | 0.94 | 3.36 | 0.39 | 4.00 | 0.86 | 5.52 |
| -Bonds | -1.41 | 6.59 | -0.25 | 5.96 | -0.96 | 6.37 | -0.58 | 9.96 |
| Agencies | 0.09 | 4.46 | 1.60 | 3.56 | 0.89 | 4.34 | 1.41 | 6.34 |

Source: annual data from Ibbotson, Siegel, and Love and Ibbotson and Fall.

Figure 1. Efficient U.S. Investment Portfolio Frontiers: 1947-69, 1952-74, 1957-79, and 1962-84; and Proportion of Farm Real Estate in Efficient Portfolios.



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