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Modern Portfolio Theory (MPT) quantifies the old investment adage: "Don't put all your eggs in one basket". MPT states that combining two assets whose returns are not fully correlated reduces the overall volatility below that of each one taken separately. The modern portfolio manager attempts to reduce volatility by seeking assets having a small or negative return correlation with the managed portfolio. Stated another way, the portfolio manager tries to reduce volatility without reducing total return. The selection of assets is thus complicated by the simultaneous desire to increase or maintain return and reduce volatility or risk.

The goal of this article is to describe return characteristics of farmland ownership so as to assess its value as a diversification tool in an asset portfolio.[1] I compare farmland index returns to other benchmarks and show gains from diversifying into farmland as an asset class; I then use Markowitz optimization to create less unwieldy, more efficient farm portfolios.

Let us begin by comparing total returns and return correlations for six asset classes: farm real estate, large capitalization stocks, small capitalization stocks, long-term corporate bonds, long-term government bonds, and U.S. Treasury bills from 1947 to 1980.

1. Footnotes appear at the end of the article.

The farm real estate data were obtained from the USDA Agricultural Statistics publications, which provided index numbers for farm real estate values. The source of these numbers is annual surveys of operators. Charles Barnard, an agricultural economist with the Economic Research Service for farm real estate, indicated in a telephone conversation that the studies he has seen regarding opinion surveys of this nature are probably accurate in the long run but with lagged adjustment periods.[2]

The rest of the data are from Ibbotson and Sinquefield (1982). Large capitalization stocks are represented by the Standard & Poor's 500 Stock Index with dividends reinvested. The small capitalization stocks are value-weighted total returns on the fifth (smallest) capitalization quintile of the New York Stock Exchange. The long-term government and corporate bond return series had approximately 20-year maturities, while Treasury bills had 30-day maturities. The Consumer Price Index (CPI) was obtained from the U.S. Department of Commerce, Bureau of Labor Statistics.

ASSET RETURNS AND CORRELATIONS

In terms of total return, farm real estate was superior to bonds and bills, virtually equivalent to large capitalization stocks and inferior only to small capitalization stocks.[2] In terms of return correlation, farm real estate was significantly correlated only with T-bills. The dual favorable attributes of real estate —

high total return and low return correlation with other assets — make it an excellent diversification vehicle.

The asset class having the lowest correlation with large capitalization (S&P 500) stocks was the T-bills, with a correlation coefficient of −0.33. T-bills, however, returned only 3.6% per year in nominal terms or −0.8% in real terms. Farmland demonstrated a slightly less negative correlation coefficient of −0.15 with the S&P, but it had much higher total returns: 11.4% nominal and 7.1% real. While the historical ability of farm real estate to reduce portfolio volatility is not as great as that of T-bills, the total nominal return on farm real estate was three times greater than on T-bills. No wonder that portfolio managers are interested in real estate!

CPI CORRELATION

The purpose of investment is to provide for future consumption. A few investors require only a certain number of nominal dollars in the future. Most investors, however, require a certain amount of wealth or purchasing power in the future. An inflation hedge is an investment that investors expect will maintain or increase its purchasing power in the event of inflation.

Real estate makes intuitive sense as an inflation hedge, because it is a tangible asset whose replacement cost increases with inflation. Empirically, real estate has proven itself an inflation hedge by having a high return correlation with the CPI.

Appendix I displays the correlation of each of the six asset classes with the CPI. Farm real estate returns had the highest correlation with the CPI at .633. The next highest was T-bills at .448. To some extent, the unique ability of real estate to hold real value in times of inflation is a transitive property of its lack of return correlation with asset classes that are negatively correlated with the CPI. Because farm real estate had the highest return correlation with the CPI and had a high positive real return during highly inflationary periods, it is a powerful inflation hedge.

STABILITY OF RETURNS

Real estate may be structured as an equity investment that offers a return comparable with the S&P 500 stocks, yet appears to be far less volatile.

This is readily apparent from the analysis in Table 1. The column MR/SD is the ratio of mean return to standard deviation, indicating the amount of return per unit of standard deviation. For each unit of standard deviation added by buying either stocks or bonds, the investor can expect ½ percent of additional nominal return; real estate or T-bills suggest an additional 1½ percent nominal return. On a real return basis, the real estate performance is even more dramatic, providing over three times as much real return per unit of added risk as the next highest ranking asset.

TABLE 1

Summary Statistics of Returns on Six Asset Classes, in Nominal and Real Terms, 1947-1980[1]

Variable	N	Mean	Standard Deviation	MR/SD
NOMINAL				
Farmland	34	11.49%	6.89%	1.69
S&P 500	34	11.54	17.70	0.65
Small stocks	34	16.19	28.15	0.58
Corp. bonds	34	2.98	6.35	0.47
Govt. bonds	34	2.39	6.03	0.40
T-Bills	34	3.64	2.42	1.50
CPI	34	4.41	4.27	1.03
REAL				
Farmland	34	7.07	5.35	1.32
S&P 500	34	7.13	19.79	0.36
Small stocks	34	11.78	29.37	0.40
Corp. bonds	34	−1.44	8.28	−0.17
Govt. bonds	34	−2.02	7.93	−0.25
T-Bills	34	−0.77	3.85	−0.20

See Appendix I for the correlation matrix.

Nevertheless,* an important caveat deserves mention. Real estate returns may be demonstrating greater stability than actually exists, because liquidity deteriorates and financing terms by sellers are liberalized during periods of declining values. In real estate, a somewhat longer investment horizon is required to mitigate against these conditions.

INEFFICIENCY OPPORTUNITIES

The objective of security analysis is to uncover undervalued or overvalued securities. The prevalent theory of market behavior is that the stock market, at least in regard to large company stocks, is very nearly efficient. An efficient market is tersely defined as one in which prices fully reflect all relevant information. Adjustments to new information are virtually instantaneous. This means that costs incurred to identify undervalued or overvalued assets rarely produce returns in excess of these costs.

The real estate market fails to meet these criteria for market efficiency.

The efficiency of a market is very much a function of the communication network that serves it. When a stock is trading on a major exchange, its transactions are immediately transmitted all over the world. Real estate transactions, on the other hand, are quiet. The only postings of real estate trades are in the county recorder's office and in the "sold" books published by multiple listing services several months after the transaction. This relative quiet creates a

profitable opportunity for those who are capable of obtaining real estate data faster than others.

Even if real estate data were freely and quickly circulated, an efficient market would not necessarily ensue. First, sale prices of real estate must be adjusted for creative financing, in order to reduce transaction prices to a cash-equivalent price. Second, each property is unique, so that complete immediate information about a given property sale would not price any other property efficiently. Third, in the portfolio context, real estate is often analyzed by non-specialists who are more at home in the stock and bond markets and who have historically ignored real estate. Therefore, profit opportunities exist for those people who are adept at specialized real estate analysis or structuring creative financing deals.

TAX BIAS

Taxable investors affect the market in which non-taxable investors participate. Depreciation is a tax-deductible non-cash expense. The tax advantages of depreciation add return value for taxable investors, but not for non-taxable investors. This allows the taxable investor to bid up prices and thereby lower before-tax returns before the market clears. Those who cannot utilize the tax advantages are at a disadvantage in the marketplace.

Usually two-thirds to five-sixths of urban real estate value is in a depreciable building offering substantial tax advantages. In contrast, farm real estate (open ground) has negligible depreciable assets on it and therefore has no appreciable tax advantages other than the low tax rate on long-term capital gains. Because of the greater tax advantages inherent in urban real estate, tax-exempt investors are more competitive bidders for farm real estate.

SELECTION AND MANAGEMENT

When you buy farmland, you are basically buying soil, water and climate. These factors not only determine what can be produced on the land in the current period, but also the future productive capacity, which has its concomitant immediate effect on the unit cost of product.

The key concept here is that the strongest industry participants are the low-cost producers. In farming, the low-cost "producers" mean the most productive land.

Certainly, an investor's objective is to purchase land that is priced below its true or economic value. Uncovering these opportunities is parallel to a security analyst's function in a financial environment. Assets should further be selected on the basis of how well they contribute to the construction of a diversified land portfolio. A diversified land portfolio would have land in several different regions capable of producing many varied crops.

Management alternatives range from hiring a manager to grow crops, to a cash rental by an independent farmer. The problem with cash rental is the conservation and maintenance of the property as well as the lower average income, since well maintained properties are obviously more salable than those that are not well maintained.

A PORTFOLIO APPROACH TO FARMING

I have conducted an investigation of the diversification potential in farmland ownership and operation, because, as a result of the underlying economics, returns to farming are volatile. The demand for food is relatively inelastic. On the other hand, food production is dependent on weather and therefore variable from year to year. The combination of these two factors causes product prices to swing widely despite government efforts to stabilize them.

Investors are averse to farming return volatility. Nevertheless, if the farm operation reached a large enough scale, the investor could begin to diversify away the volatility.

I combined information from several sources to generate a 25-year net income history for 81 crop-region combinations. Crop-regions refer to a particular crop in a particular region.

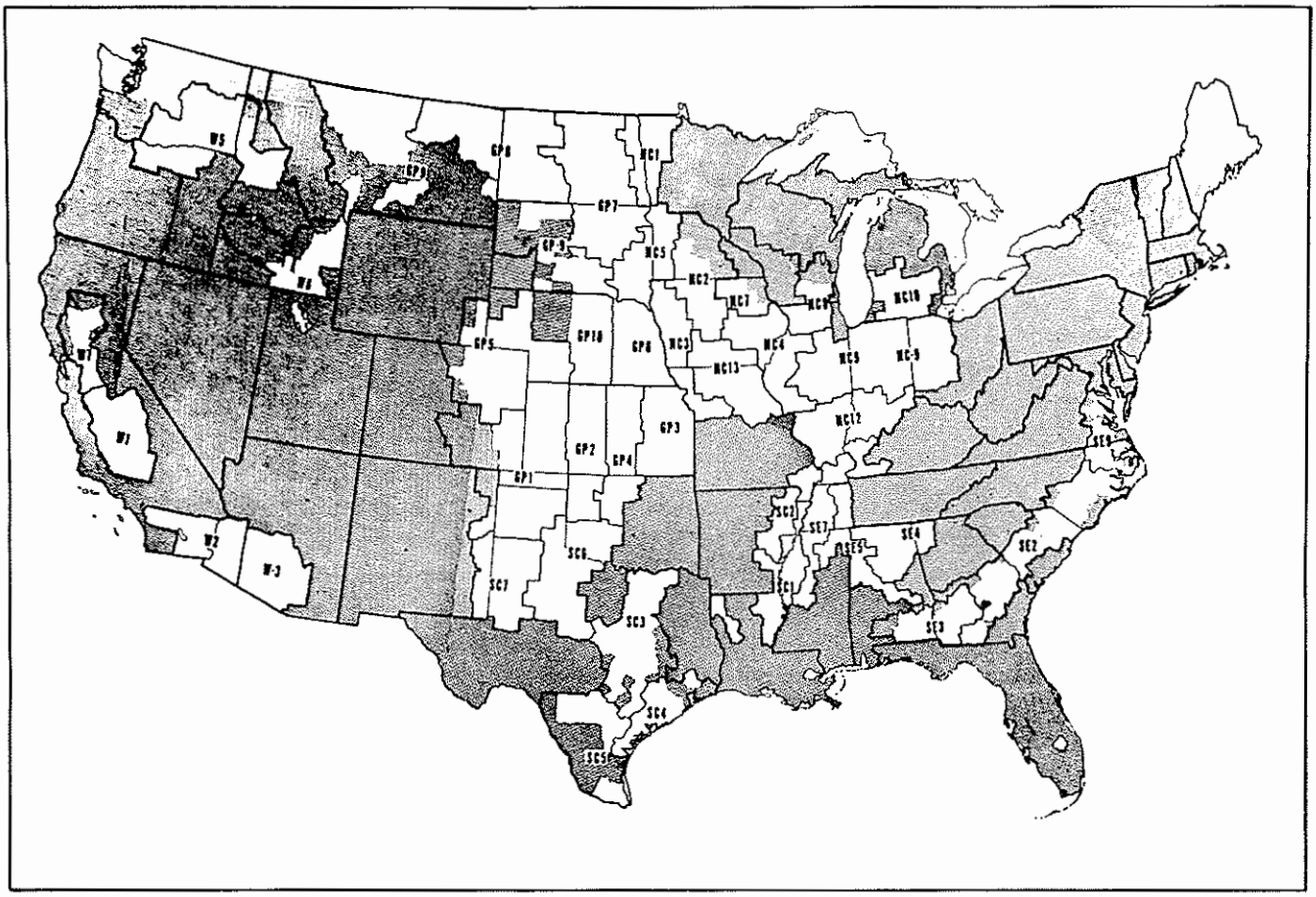
The net income was computed by the following procedure. First, the State Crop and Livestock Reporting Services provided average yield per acre by crop-region, and the U.S.D.A. provided state average commodity prices received by farmers. By multiplying the two together, I created a gross income history for the 81 different crop-regions.

Second, due to a 1974 legislative dictum that ordered the U.S.D.A. to prepare cost of production studies, I was able to obtain cost data specific to U.S.D.A.-defined regions. The gross income data and the cost data were from different sources, and the income and cost regions do not correspond perfectly, making it necessary for me to devise a system for mapping gross income data into cost data.

For example, Iowa is composed of five costs and nine gross incomes. The gross incomes are divided into nine areas defined by their compass relationship to the center. It was necessary to assume which costs best represented costs of a given gross income. The map in Illustration I shows that southwest Iowa is mostly composed of cost NC3. This was the cost that I assumed corresponded with gross incomes of southwest Iowa. South middle Iowa is a majority of costs NC13. Southeast Iowa corresponds

ILLUSTRATION 1

PRODUCTION REGIONS FOR CROP COST ANALYSIS



with costs NC4. In those areas where there are no cost data, I simply projected nearby cost data for that particular gross income. 1974 costs of production were adjusted to prior years by use of the U.S.D.A. Index of Prices Paid by Farmers. By subtracting the cost data from the gross income data, I arrived at a *net income per acre history* over 25 years for 81 crop-regions.

The best data available for generating capital gains returns were at the state level. There were no regional (smaller than state) data available. Therefore, I assumed that the land value within a given state changed uniformly, which is a smoothing assumption.

The combination of the net incomes per acre for crop-regions and the capital gains per acre history gave a 25-year multi-crop region history of total returns to farmland ownership and operation. The documented numbers are available on request.

The full variance-covariance matrix of the farmland total return data was generated and optimized for minimum standard deviation at various levels of expected returns. The algorithm selects that crop-region that most reduces the portfolio standard deviation for a given level of expected return. The entire efficient frontier (see Illustration 2) represents those crop-region combinations that have the lowest risk for each given level of return.

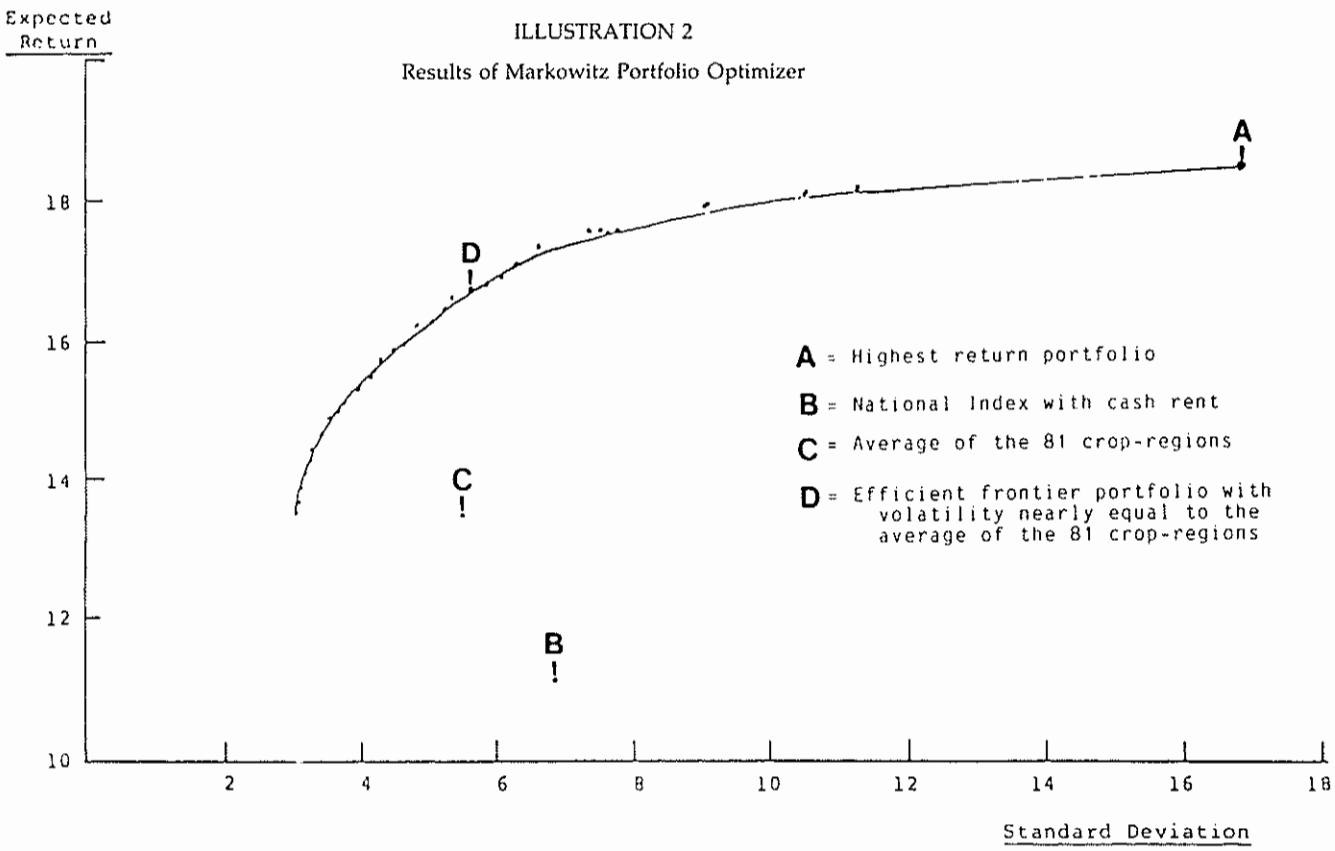
The highest return crop-region was wheat in northeast Kansas, for an average return of 19.41% with a standard deviation of 16.77%. For a portfolio of 40% northeast Michigan (Saginaw Valley) corn and 60% northeast Kansas wheat, the average total return dropped only one-tenth of a percent while the standard deviation dropped 5.3%, indicating tremendous volatility reduction by adding only one different crop-region to the portfolio.

The next crop-region selected by the portfolio optimizer was middlewestern Iowa soybeans. This crop-region was assigned a weight of 23% of the portfolio.

In the next portfolio, another Michigan corn region was included to represent 7.4% of the portfolio, half from reduction of the Kansas wheat and half from the reduction of the original Michigan corn.

ILLUSTRATION 2

Results of Markowitz Portfolio Optimizer



Note that the average of the 81 crop-regions was an expected return of 13.5% with a standard deviation of about 5.6%. An efficient frontier portfolio with nearly the same level of standard deviation had an expected return of 17.64%, or 4.1% more than the average.[5] This represents the gain to optimized farm portfolio selection. The optimized portfolio with a risk comparable to that of the 81 crop-region average is composed of 13 crop-regions as shown below:

19.32%	SC	Iowa Soybeans
17.10%	SE	Michigan Corn
12.90%	WC	Iowa Soybeans
12.02%	NE	Kansas Wheat
10.53%	NW	Michigan Corn
8.46%	NW	Kentucky Corn
6.53%	MS	Kentucky Corn
3.76%	MN	Kentucky Corn
2.49%	C	Arkansas Cotton
2.28%	WC	Kansas Corn
2.17%	NE	Kentucky Corn
1.75%	NW	Arkansas Cotton
0.67%	SE	Kentucky Corn

The five largest crop-regions represent 71.87% of the portfolio.

THE INVESTMENT ATTRACTION

Risk-averse investors have much to gain from diversification in farm operation management. This study indicates that the Markowitz optimization technique for selecting farm property can raise expected return to 17.1% from the 13.5% return expected from random selection.

Since almost 75% of the above portfolio is composed of only five crop-regions, and because of the economic efficiency of growing more than one crop on a particular farm, I conclude that sufficient diversification can be achieved by establishing five farm units. If an efficient farm unit is 640 acres, or one square mile, a portfolio of five one-square-mile farms could produce sufficient diversification to reduce portfolio volatility significantly. There are a great many institutional investors with enough assets to implement a Markowitz-based program of farmland selection, whereas an indexed portfolio would be prohibitively expensive. At current land prices, a portfolio of five properties with a risk-return profile close to the efficient frontier can be acquired with less than $13 million.

APPENDIX I

Correlation Coefficients:

	NOMINAL						
	Farmland	S&P 500	Small stocks	Corp. bonds	Govt. bonds	T-Bills	CPI
Farmland	1.000						
S&P 500	−0.150	1.000					
Small stocks	0.019	0.794	1.000				
Corp. bonds	−0.043	0.136	0.024	1.000			
Govt. bonds	−0.103	−0.041	−0.126	0.889	1.000		
T-Bills	0.460	−0.329	−0.045	0.000	0.073	1.000	
CPI	0.663	−0.398	−0.215	−0.185	−0.160	0.448	1.000
R*Farmland	0.547	0.253	0.266	0.151	0.046	0.091	−0.264
R S&P 500	−0.277	0.980	0.757	0.161	−0.002	−0.391	−0.572
R Small stocks	−0.078	0.819	0.990	0.050	−0.097	−0.108	−0.352
R Corp. bonds	−0.375	0.309	0.129	0.862	0.764	−0.231	−0.658
R Govt. bonds	−0.436	0.183	0.020	0.776	0.847	−0.186	−0.660
R T-Bills	−0.446	0.235	0.211	0.205	0.223	0.133	−0.827

	REAL					
	Farmland	S&P 500	Small stocks	Corp. bonds	Govt. bonds	T-Bills
R Farmland	1.000					
R S&P 500	0.283	1.000				
R Small stocks	0.293	0.809	1.000			
R Corp. bonds	0.252	0.419	0.220	1.000		
R Govt. bonds	0.177	0.306	0.116	0.935	1.000	
R T-Bills	0.350	0.388	0.322	0.583	0.615	1.000

*R: Real

[1] I make the clear distinction between farmland ownership and farming. Farmland ownership is when land is owned and cash rented at an assumed rate of 4% of value. The farmland owner enjoys the receipt of rent and the appreciation of the land value. Farming is the operation of growing crops on the land. A farmer must pay rent to the farmland owner if he does not own the land himself. It is the volatility of farming that has caused the non-agricultural investor to believe that farmland ownership is riskier than it is.

[2] Farm real estate data are lagged one year for two reasons. First, the reported data are for March 1 of the reported year. Therefore, to improve comparability with the calendar year returns of all the other assets in the study, I used the previously reported year for the farm real estate. Second, by adjusting the farm real estate data backward by two months, the lagged bias is somewhat accommodated.

[3] The arithmetic mean of a volatile series will be higher than the geometric mean. Given that the large capitalization stocks are more volatile than farm real estate appears to be, the farm real estate returns would be higher than the S&P 500 returns when comparing the geometric means.

[4] The farm real estate return standard deviation was adjusted for first order serial correlation by a factor of 1.4.

[5] It is important for the reader to realize that the indicated returns are upward biased, because the quadratic program seeks the best experienced returns. Those returns could be achieved by ex ante investment purely by chance. The upward bias on these select portfolios is substantial and of unknown magnitude. As the number of crop-regions in a portfolio increases, the upward bias diminishes.

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