RISK AND RETURNS IN AGRICULTURAL ASSETS

MEASUREMENT ISSUES

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1 INTRODUCTION

From an historical perspective, agricultural economists and farm management workers have been interested in the returns from farm activities for a considerable period of time. Interest in the risk dimension has arisen more recently. The purpose of this paper is to outline the general process of estimating the returns and the associated risk generated by agricultural assets.

In the early days of farm management research, considerable emphasis was placed on farm level data captured from farm operators' account books or through questionnaires. The history of comparative analysis in agriculture goes back to Warren at Cornell University just after the turn of the century. Many of the Land Grant Universities in the United States developed farm account book and analysis projects. Notable among these were Michigan State University and the University of Illinois. Most countries in the European Economic Community have undertaken similar approaches as have most Canadian provinces. Alberta has a long history of cost of production studies, first on milk and later on other commodities. These cost studies grew into farm management extension projects in the late 1950s and in the 1960s. In the 1970s Agriculture Canada funded a major undertaking in the Canadian Farm Management Data System (CANFARM). A major thrust of CANFARM was to assemble a data base founded upon accounting data gathered at the farm level. See Plaunt (1967) for a discussion of the underlying philosophy of CANFARM. While the accounting system was used by as many as 10,000 farmers across the country[1] the data base aspects did not achieve the same success.

In the University of Alberta Farm Management Field Laboratory, accounting data were gathered from approximately 50 farmers per year in each of the five years from 1979 through 1984. The CANFARM Version 3 Accounting System was used as the main data gathering device. A fieldman was hired from project funds to assist participating farmers in setting up and maintaining the accounting system and in developing office procedures to ensure a reasonable degree of accuracy. The annual budget of the project was approximately $50,000 resulting in a cost per farm of $1,000. Of the 50 annual participants, 16 farm operators took part continuously over the five year period ending in 1984.

2 THE BASICS OF MEASURING RISK AND RETURN

A widely accepted measure of financial result is 'return on investment'. It is a part of common language to talk about the yield of Canada Savings Bonds or of Treasury Bills or the return made by investing in corporate bonds, in the stock market or in a mutual fund. The implicit calculation in these commonplace expressions is to divide the dollar return by the dollar amount invested.

$$r_t = \frac{(V_t - V_{t-1}) + R_t}{V_{t-1}}$$

1 CANFARM was an organ of the Government of Canada and during budgetary difficulties the program was essentially terminated without a smooth transition into private hands.

where:

r_t represents the rate of return earned in period t,

V_{t-1} is the asset value at the beginning of t,

V_t is the asset value at the end of t,

R_t represents the dividend earned in period t.

To express the performance of a particular financial asset over time annual returns are frequently summarized by the mean and standard deviation. Specifically, the mean is calculated by:

$$\bar{r} = \frac{1}{n} \sum_{t=1}^{n} r_t$$

where:

$\bar{r}$ represents the average or expected return over n periods.

Variance or the standard deviation, its square root, is a measure of risk expressed in terms of deviations from the expected value. Specifically, the variance is calculated by:

$$s^2 = \frac{1}{n-1} \sum_{t=1}^{n} (r_t - \bar{r})^2$$

where:

s^2 represents the variance of return over n periods.

Data measuring the performance on various segments of the security markets are widely available and extensively used in finance related research. For an example of widely available security market data see R.G. Ibbotson Associates (1983-). Unfortunately, in agriculture such data are not readily available. This is due partly as a result of the structure of agricultural firms, and perhaps also because of our approach as researchers in the field.

3 RISK AND RETURN ON AGRICULTURAL ASSETS

From an investment point of view, agricultural assets, including farm businesses, have characteristics similar to investments in common stock. Investors in farm businesses, like investors in common stocks, have expectations of both dividend or income and capital appreciation.

3.1 Measuring Rate of Return Directly from Accounting Data

To make the analysis of a farm business comparable to investments generally a number of adjustments must be made. In the first place financial securities have had all costs deducted before the return was calculated. The operator of the sole proprietorship farm business, however, has invested not only capital, but also labour and managerial effort. This contribution should be accounted for by assigning a value for the provision of this service. In the second place, financial assets were analyzed without regard to the method used for

acquiring investment funds. The position taken was that the return would be the same whether one's own funds were used for the purchase or whether funds were borrowed. The net income figure for a farm business usually includes a deduction for interest paid out on liabilities. This must be added back in to arrive at a figure comparable to that calculated for the investments generally. Return to assets from farming operations is therefore the net return after salaries have been paid but before interest payments have been deducted.

Income from farming operations is equivalent to the dividend portion of common stocks. Farm businesses also have a capital gains and losses component comparable to that found in the stock market. Capital assets, including agricultural assets, have value because investors expect economic benefits from them. Therefore, if the income potentials from operations are high, investors will be eager to hold the assets, and accordingly pay a high price for them. If income prospects were not as strong, investors would respond accordingly and asset values would fall.

The method used for calculating the return in the farm business case can be summarized with the following formula:

$$r_{A,t} = \frac{[N_t - S_t + I_t] + \Delta A_t}{A_{t-1}}$$

where:

$r_{A,t}$ is the percent return on assets,

N_t is the net income,

S_t is the salary paid or earned by the employees and operator,

I_t is the interest expense,

ΔA_t is the dollar change in asset value,

A_{t-1} is the value of assets at the start of the period.

On the surface it seems reasonable that one should examine the account books of farm businesses if one is to understand farm business performance. Certainly much can be learned in this way about the structure, performance and organization of a particular farm business, and such information is vital in sound farm management counseling. But while this approach seems reasonable for risk and return measurement in the industry, it may also contain elements of impracticality. The reasons for impracticality are rooted in the cost of obtaining data that are accurate and at the same time statistically representative. Experience with participants in the Farm Management Field Laboratory suggests that the number of farm businesses with accurate and detailed accounting data is not large. Even with participants of superior managerial capability, considerable assistance in keeping an accurate and relevant set of books was provided by the laboratory fieldman. The number of farm businesses willing to participate on a continuing basis, for perhaps five years or more, are even less plentiful. These factors seriously limit the practicality of maintaining a time series of reliable risk and return data directly from farm operations and lead to the

conclusion that obtaining quality data, which accurately represent the risk and return dimensions of farm operations, directly from accounting data is an expensive and questionable proposition.

3.2 Measuring Risk and Return Indirectly from Market Data

An alternative to large samples based on farm accounting data is to measure the performance of key agricultural assets indirectly, as revealed by exchanges made in the market place. Risk and return data for non-agricultural investments are common place. For example the Toronto Stock Exchange 300 industrial index and earning statistics for specific industries are readily available. Unfortunately, in agriculture we do not have such readily available information. Such an approach would require the construction of series of performance statistics for a variety of agricultural assets. A number of examples of such research are discussed below.

3.2.1 Investment in farmland

Farmland is an important asset in agriculture, without doubt representing the single biggest asset on most Canadian farms. Research into the performance of this asset has been conducted on dark brown soils in central Alberta by Bauer (1983) and on the entire province of Alberta by Phillips et al (1989). In the Phillips research, a series of returns was developed to model the experience of a possible investor in Alberta farmland who was assumed to have purchased land at the start of the year, collected rental income from it and sold at the end of the year. The model for this study, which spanned the period 1963 through 1985, was developed following traditional risk, returns methodology.

$$r_t = \frac{(V_t - V_{t-1}) + R_t}{V_{t-1}}$$

where in the farmland case:

r_t represents the rate of return earned on the farmland investment in period t

V_{t-1} is the value of an acre of farmland at the beginning of t

V_t is the value of an acre of farmland at the end of t

R_t represents the rental income earned during period t.

The income portion, comparable in concept to dividends from common stock, was derived from rent based upon a one quarter - three quarters crop share. The capital portion is based upon annual changes in market value of the land. The average return over the 23 year period was 20.97% (13.62% real) with a standard deviation of 19.91%. Farmland earned a premium of 13.20 (12.18 real) percentage points over the risk free return from treasury bills. Farmland outperformed the stock market over this same period by a considerable margin.

3.2.2 Investment in beef feeder cattle

Custom feeding of beef cattle has increased in popularity in western Canada. Typically an investor purchases feeder cattle, places them into a commercial feedlot, pays for the feed, medicine, transportation and yardage costs and receives the proceeds from the sale of finished cattle at the end of the feeding period. Recently, Bauer et al (1989) modelled a typical beef feeding process for the period 1972 through 1985.

In this market data based study, the investor was assumed to purchase 100 head of 380 kg feeder steers at the start of each month and place them into a commercial feedlot for approximately 120 days at which time they would be sold at a final weight of 520 kg. Profit predictions were made at the start of each feeding period on the basis of futures prices for contracts on finished cattle traded in the Chicago market. Technical performance data were obtained from feeding trials reported in animal science literature. Realized finished cattle prices, feeder cattle prices and feed ingredient costs were obtained from market data collected by Alberta Agriculture.

The basic model for estimating percentage returns from the cattle feeding enterprise involved the determination of costs incurred at the start of the investment period and the revenue recovered at the end. Although costs were incurred during the feeding period, they were brought back to present value as at the start of the period. Price predictions for finished cattle were based on futures contracts traded on the Chicago market. Considerable effort was invested in building the data series. The series should be further refined and continuously updated for further research. Percentage return for a particular investment period was then calculated as:

$$r_t = \frac{R_t - C_{t-k}}{C_{t-k}}$$

where:

r_t represents the percentage return from the investment during period t evaluated at time $t - k$,

R_t represents the revenue received at the end of the feeding period having a length of k months,

C_{t-k} represents the outlay of costs brought to present value at the start.

The length of the time series was limited to 13 years or 156 feeding periods, constrained by the availability of market data. Data analysis included the calculation of expected return and mean square error (MSE) as follows. Mean square error was chosen as the appropriate measure of risk because it incorporates the price information available to the investor at the time of decision.

$$\bar{r} = \frac{1}{n}\sum_{t=1}^{n} r_t$$

$$s^2 = \frac{1}{n}\sum_{t=1}^{n} (\hat{r}_t - r_t)^2$$

where:

$\bar{r}$ represents the expected percentage return,

s^2 represents the mean square error or unpredictable error surrounding the expectation,

$\hat{r}_t$ represents the predicted return for period t based upon futures prices,

r_t represents the realized return.

Appropriate tests were performed to identify and adjust for trends in the data. Correlation analysis was conducted to determine measures of the covariance between beef feeding returns and other investment opportunities, notably the stock and money markets.

Under the main investment strategy, where the investor purchased 100 head at the start of each month, an annual return of 6.32% with a root mean square error (RMSE) of 41.1% would have been achieved. The comparative return in the stock market was 4.65% return with a standard deviation of 37.6%. Under an alternative investment strategy cattle would have been fed only if the expected return was greater than the T-Bill rate at the start of the month. When feeder cattle appeared to be less profitable than T-Bills the investment for that month would have been placed into 90 day T-Bills rather than feeder cattle. The return under this more selective strategy rose to 9.00% and the root mean square error declined to 34.2%.

3.2.3 Investment in crop activities

Another project was recently completed by Mumey et al (1989) in which the risk and returns from cropping alternatives on Alberta grain farms were studied. The central theme of the study was to investigate the risk related rationale for farmers to follow a multiple crop program including wheat, barley and canola as opposed to a mono culture cropping pattern. Additional objectives included investigation into the relative and absolute variability of revenue of each of the three crops, the stability of risk patterns over time, risk differences between crops, the effect of crop insurance and the interdependence among crops.

Data for crop yields were obtained from Alberta Wheat Pool crop reports as estimated by elevator agents at elevator points which typically serve areas within a 10 to 20 km radius. Realized prices obtained from Canadian Wheat Board sources. Price forecasts were based on Canadian Wheat Board initial payment announcements and futures

contracts traded on the Winnipeg and Chicago markets. Grade factors were determined from Canadian Wheat Board payouts and Alberta Hail and Crop Insurance Corporation records.

4 CONCLUSIONS

Understanding business performance through the account books of individual farms requires detailed data which is something individual farm operators are not always fond of gathering and sometimes even reluctant to disclose to others. Not only are the data required detailed, they must be verified as to accuracy if they are to have scientific validity. On the other hand, questionnaires which are less costly to administer, rely on the casual remembering by farmers of their business activities and are not likely to yield results that can withstand the tests of validity. Furthermore there is the possibility of systematic bias both in record keeping projects and in questionnaires, because the respondent may find it advantageous to either over or under report the actual financial result. Statistical representativeness requires a large sample size. Appeal to the "law of large numbers" to cancel out random error is based on the notion of a zero bias in the respondents.

Record keeping projects have frequently been associated with farm management extension projects. This additionally compromises results because participants are provided instruction on improved management practices and if the farm management advice is influential in improved practice, then the participant no longer represents the population.

Apart from the limitations outlined, experience has shown that projects for gathering accounting data that accurately reflect the performance of the farm businesses in cross section and, especially through time can be quite costly.

The market based studies cited above are attempts to use available technical and price data to evaluate the performance of agricultural assets and to relate that performance to investments outside of agriculture. In each of the studies reported, a disproportionate amount of time was used in gathering and testing the validity of data seriously limiting the time and funds available for investigating the more interesting economic policy issues.

Because data series do not go back very far into history the studies were limited in scope. It is important to maintain such series into the future so that a better understanding of asset performance in agriculture can be developed.

Results of such studies will provide a better understanding of investment opportunities in the agricultural industry, thus enabling farmers and others to make more informed investment choices. Agricultural policy issues, particularly those in the risk reduction and stability area can be evaluated more effectively by information generated by such research. Information on the levels and sources of risk should also be of value to agricultural credit agencies in lending decisions, particularly as related to the overall risk of loan portfolios. Extension agents and farm advisors will be facilitated in their farm management counselling activities.

Continued research will add important series of financial information to existing data bases and further develop the methodology of financial analysis as applied to agricultural investments.

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