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FARMING AT THE EDGE

SHOULD FARMERS INVEST IN FINANCIAL ASSETS AS A RISK MANAGEMENT STRATEGY? SOME EVIDENCE FROM NEW ZEALAND

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Abstract

Off-farm investment as a risk management strategy is not widespread among New Zealand sheep and beef farmers. This study explores the potential for risk reduction by the diversification of farm asset portfolios to include financial investments such as industrial equities and government bonds of various types. Results show that the negative correlations between long-run rates of return on farm assets and financial investments could result in a significant reduction of risk if equities and bonds were included in farm investment portfolios. However, when combined with information about attitudes to risks, it does not seem likely that farmers would adopt such strategies purely in order to stabilise incomes. Deregulation of the New Zealand economy in the mid 1980's had little impact on farmers' optimal allocation of their assets.

Surveys of farmers and growers in New Zealand (NZ) have revealed that their preferred risk management strategies retain a predominantly on-farm focus (Martin, 1996). In order to stabilise their returns, farmers and growers were found to rely mostly on precautionary measures such as spraying and drenching, farm enterprise diversification, and keeping debt levels low. Off-farm financial strategies for reducing risk, such as investment in financial assets were not favoured, perhaps because these were not perceived as particularly efficient strategies for managing risk.

However, it is possible that there was a significant gap between farmer perceptions and the reality of the potential for off-farm diversification. In a US study, Young and Barry (1987) showed for Illinois grain farms, that investment in financial assets could reduce the relative variability of a farm's rate of return on assets by up to 25% as compared to holding farm assets alone. In New Zealand, apart from a paper by Narayan and Johnson (1992) using the capital asset pricing model (CAPM) to compare off-farm versus on-farm diversification, no significant studies have been found in this area.

The purpose of this paper is therefore to investigate the importance of off-farm investments as a possible risk management strategy for NZ sheep and beef farmers. Our approach is to use data for variability of returns of the different classes of asset derived from historic sources. We use a simple portfolio-type analysis in order to quantify the risk-reduction benefits of moving from farm assets alone to an investment portfolio of farm and financial assets. Having quantified these benefits, we then turn to the question of whether they are sufficient to persuade farmers to switch investments in the light of their own attitudes to risk. Finally, we investigate whether the deregulation of the New Zealand economy, which took place in 1984, had an impact upon the relative risks of investing in farm-based assets as opposed to financial assets. In other words, we examine whether New Zealand sheep and beef farmers should have altered the composition of their asset holdings following the deregulation.

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Portfolio Theory

Portfolio theory as developed by Markowitz (1952) and others suggests that the choice of an optimal asset combination or portfolio depends upon the mean and variance of the portfolio's return. A risk-efficient portfolio is defined as a combination of assets which maximises the expected returns for a given level of risk (measured as variance or standard deviation).

Within the risk-efficient set, the rational investor will choose that portfolio which has, for him or her, the highest certainty equivalent (CE). In the mean-variance case, the certainty equivalent is maximised where

$$dZ/d\sigma^2 = \_.A \qquad (1)$$

where Z is the expected return, σ is the standard deviation of the return and A is the Pratt-Arrow coefficient of absolute risk aversion. Critical levels of A, where the utility maximising portfolio changes, can thus be calculated from the slope of the risk-efficient frontier and compared with empirical estimates of farmers' attitudes to risk.

Data

Time series data relating to annual rates of return on shares, short-, medium-, and long-term bonds, and on farmland were obtained for the period spanning 1966 to 1996. Annual rates of return were calculated as the sum of the current return and the capital gain, expressed as:

$$R_{it} = D_{i1} + (A_{i1} - A_{i0}) / A_{i0} \qquad (2)$$

where R_{it} the total rate of return in year t for the ith asset, D_{i1} is the current return, A_{i0} is the asset value at the beginning of each year, and A_{i1} represents the asset value at the end of the year.

Ordinary shares

Returns on equity investments were calculated from the New Zealand Stock Exchange NZSE40 Capital Index (known, prior to 1991, as the Barclays Index). This index covers 40 of the largest and most liquid shares weighted according to their market capitalisation.

Government Bonds

Bond categories reflected the Reserve Bank of New Zealand's (RBNZ) changing bond classifications over the study period. We classified them into three groups. *Short-term bonds* included securities with maturity dates between 6 months and 3 years for 1966-1976; 6 months and 2 years for 1977-1986, and of 1 year for 1987-1996. *Medium term bonds* referred to securities with maturity dates between 3 and 10 years for 1966-1976; 2 and 5 years for 1977-1986; and of 5 years for 1987-1996. *Long term bonds* referred to securities with maturity dates of over 10 years for the period 1966-1976; over 5 years for 1977-1986; 5 years for 1987-1990; and 10 years for 1991-1996. Each of the three bond classifications thus covered a range of maturity dates. Yields for a particular group were taken as the average of yields within the group. Bond rates of return were taken as current yields i.e., coupon/current price of the bond, as published by the Reserve Bank of New Zealand (RBNZ).

Sheep and Beef Grazing Farmland

Rates of return from farmland were taken from the New Zealand Sheep and Beef Farm Survey (NZMWBES, various dates). The yearly total farmland rate of return for beef and sheep farms was taken as the sum of the production rate of return and the capital gain. The production rate of return was taken as the weighted average rate of return on assets for all classes of sheep and beef farms in the NZMWBES. The capital gain component was represented by the annual percentage change in the grazing land price index (Valuation New Zealand, various dates).

Results

Comparative variability of assets

Table 1 shows the mean, standard deviation, and coefficient of variation of the annual rates of return on farmland, shares, and government bonds over the period. All these values are in nominal terms. The data reveals that farmland outperformed the share and bond markets in terms of mean rate of return over the study period, though one should note that because of the definition of the Capital Index, the returns to shares reported exclude dividends. Long-term bonds on the other hand, have outperformed short- and medium-term bonds both in terms of mean rate of return and standard deviation. In the following analysis, rates of return were adjusted for inflation and are therefore presented as real rates in all subsequent tables and diagrams.

Table 1. Risk and Return Measures for Farmland, Shares, and Bonds, 1966-1996, (nominal)

	Mean rate of return (%)	Standard deviation (%)	Coefficient of variation (%)
Farmland:			
Production return	3.61	1.61	45
Capital gain	12.31	14.88	121
Total rate of return	15.92	15.14	95
Shares	12.19	33.50	275
Short-term bonds	9.40	4.95	53
Medium-term bonds	9.54	4.19	44
Long-term bonds	9.67	3.92	41

Table 1 shows that the coefficients of variation ranged from a low of 41% for long-term bonds to a high of 275% for shares. Share rates of return were clearly the most volatile among the assets considered. Their rates of return were up to seven times more volatile than those of bonds and almost three times more volatile than those of farmland. The investments could be ranked according to level of risk as follows: bonds, farmland, and shares.

Comparing their coefficients of variation, the capital gain component (C.V. = 121%) is nearly three times more variable than the production return (C.V. = 45%). The production rate of return to farmland was as stable as the yield on medium-term and long-term bonds.

Table 2. Correlation Coefficients Between Farmland and Financial Assets

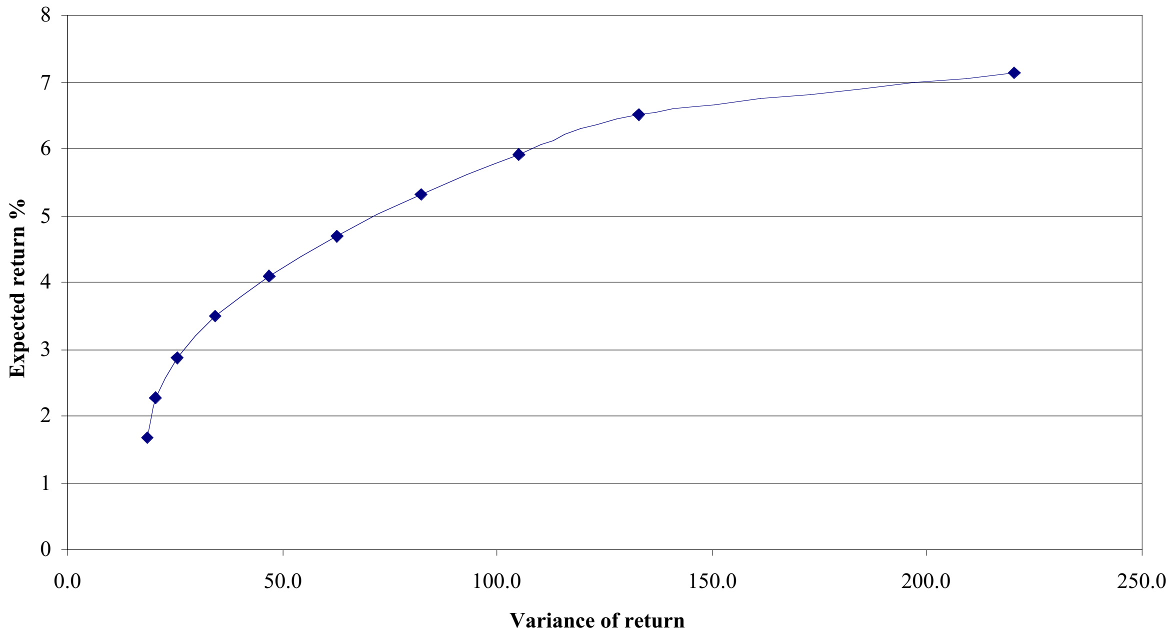
	Farmland	Shares	Short-term bonds	Medium-term bonds	Long-term bonds
Farmland	1.00				
Shares	-.38	1.00			
Short-term bonds	-.23	.20	1.00		
Medium-term bonds	-.17	.25	.98	1.00	
Long-term bonds	-.14	.22	.98	1.00	1.00

The correlation coefficients between the rates of return on farmland and the financial assets are shown in Table 2. Farmland rates of return are negatively correlated with share rates of return and bond yields. This indicates that substantial risk reduction could be obtained by combining an investment in farmland with investments in financial assets. Farmland rates of return are most negatively correlated with shares and least negatively correlated with long-term bond yields. Bond yields are highly correlated with each other with correlation coefficients ranging from .98 to 1.00. Share rates of return are weakly positively correlated with bond yields. This implies that combining shares and bonds could also result in significant risk reduction, but holding a portfolio of government bonds alone would not.

Benefits of diversification

The risk reduction benefits from combining farm assets with financial investments were quantified using portfolio analysis. Figure 1 shows the risk-efficient portfolios and table 3 shows the composition of ten of these portfolios together with their risk characteristics. Neither short- nor medium-term bonds appear in any of the risk-efficient portfolios. This is because both short- and medium-term bonds are highly correlated with long-term bonds which also dominate them both in terms of mean rate of return and variability of rate of return.

Figure 1 Risk - Return Diagram, pooled 1966 - 1996 data



Portfolio 10 in table 3 represents the minimum variance portfolio with a mean return of 1.7% and a standard deviation of 4.3%. Moving leftwards in table 3, portfolios with higher rates of return are obtained by increasing the proportion of farmland and including shares in the mix, while correspondingly decreasing the amount of long-term bonds. Still higher rates of return are obtained by eliminating bonds from the portfolio and just investing in farmland and shares. Portfolio 2, which consists of

83.7% farmland and 16.3% shares, gives a mean rate of return of 6.5% and offers a 15.1% reduction in risk. Portfolio 1 has the highest rate of return, holding only farmland. By definition, this "portfolio" also has the highest level of risk.

Utility-maximising portfolios for New Zealand farmers

Whilst it is clear from the previous section that there are benefits to be gained from diversification by reducing risk, the question now arises as to whether such benefits outweigh the costs of expected income forgone, in terms of the manager's utility. This question can only be answered by relating the results to the attitudes to risk of the individual decision maker. In the absence of such detailed information, we have calculated the critical values for each portfolio of A, the coefficient of absolute risk aversion, using equation (1). This critical value shows the degree of risk aversion needed to just make the indicated portfolio the utility-maximising portfolio. Thus, whilst the risk indifferent manager, or one for whom $0 \le A \le 0.0139$, would choose portfolio 1, a manager for whom $0.0139 \le A \le 0.0434$ would choose portfolio 2. The process continues until portfolio 10, the minimum-variance portfolio, which would only be chosen by a manager whose coefficient of absolute risk aversion in greater than 0.6471.

Table 3 Risk Efficient Portfolios, 1966 - 1996 pooled data

	Portfolio									
	1[a]	2	3	4	5	6	7	8	9	10[b]
Composition (%)										
Shares	0	16.3	16.7	14.4	12.0	9.7	7.4	5.1	2.7	0.4
L.T. Bonds	0	0	9.5	20.6	31.7	42.8	53.9	65.0	76.1	87.2
Farmland	100.0	83.7	73.9	65.1	56.3	47.5	38.8	30.0	21.2	12.4
Expected return (%)	7.1	6.5	5.9	5.3	4.7	4.1	3.5	2.9	2.3	1.7
Variance of return	220.2	132.7	105.1	82.3	62.9	46.9	34.6	25.7	20.4	18.6
Critical values of A* [c]	-	0.0139	0.0434	0.0535	0.0630	0.0764	0.0972	0.1376	0.2313	0.6471

a Maximum expected return portfolio
b Minimum Variance Portfolio
c using equation (1)

Estimates of the coefficient of absolute risk aversion for individual farmers or for groups of farmers have been carried out using a number of frameworks and in a variety of situations. Saha, Shumway and Talpaz (1994) reviewed a number of studies which showed very variable results. Nevertheless Thornton (1985) provides one of the few examples of the empirical estimation of the risk attitudes of New Zealand farmers. In his sample of 12 cereal growers he found four who showed risk indifference or slight risk preference (i.e. $A \ge 0$) and eight who showed varying degrees of risk aversion. The maximum value of A in his sample was

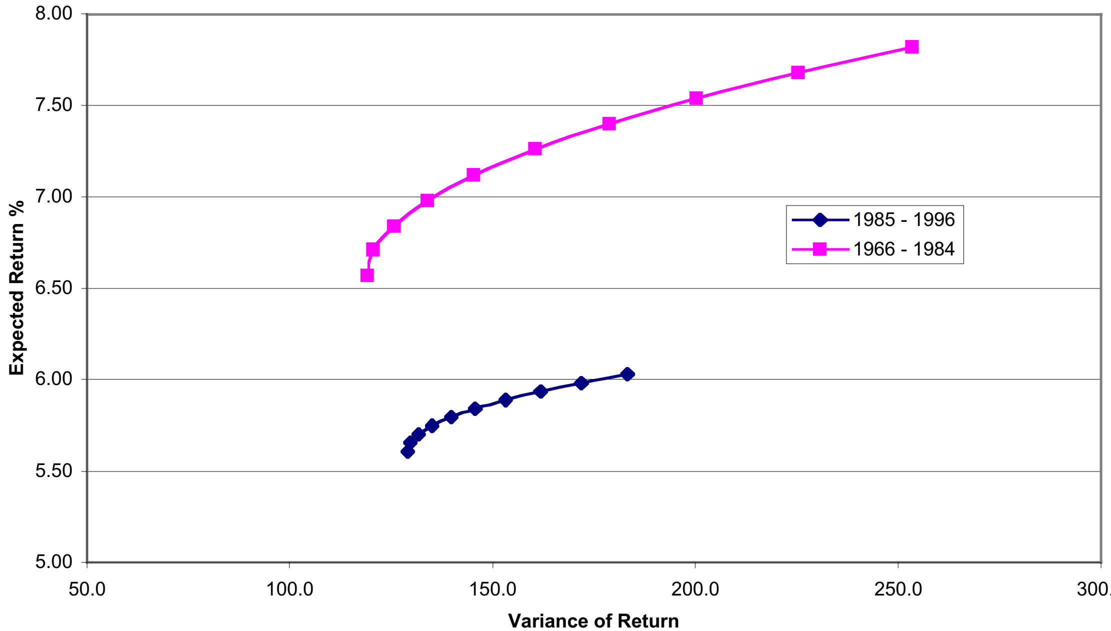
0.0008 which related to 1984 New Zealand dollars. If we assume that, given the deflation of the New Zealand dollar since then, the 0.0008 estimate is unlikely to be exceeded today and if this value is applied to the set of portfolios shown in table 2, it would suggest that Thornton's sample of farmers would choose Portfolio 1, since 0.0008 is less than the critical value of A for Portfolio 2. In other words, despite the fact that they showed risk aversion, their degree of risk aversion would not be large enough for them to gain utility by shifting to portfolio 2.

Alternatively, Hardaker, Huirne and Anderson (1997) have suggested a range of values for the coefficient of relative risk aversion, R, of between 0.5 and 4 with a typical value of 1. Indeed, they suggest a typology ranging from "R = 0.5, hardly risk averse at all" to "R = 4.0, almost paranoid about risk". Bearing in mind that R = A.w , where w is wealth (Newbery and Stiglitz), it is possible, by assuming various levels of wealth, to find whether someone who is "almost paranoid about risk" would switch portfolios. By assuming a relatively low level of wealth at NZ$100,000, we thus calculate a value for A of 4/100000 = 0.00004 for such a person. This, too, is well below the critical value needed before the decision maker would gain utility by shifting to portfolio 2 in table 3. We therefore conclude that utility maximising portfolios for New Zealand farmers are unlikely to include shares or bonds, if income risk management is the main purpose of such holdings.

The effect of the deregulation of the New Zealand economy

We now turn to the consideration of the impact of deregulation of the New Zealand economy upon farmers' asset management decisions. The process and effects of the deregulation have been well described elsewhere (Frengley and Englebrecht, 1998). Whilst there may well have been an impact on absolute levels of variability of returns, our interest focusses upon whether or not the relative changes were sufficient to suggest modifications to the optimal portfolios of assets held by farmers.

Figure 2 Risk Efficient Frontiers, Pre and Post Deregulation



The data series was split into two periods, namely 1966-1984 covering the pre-deregulation period and 1985-1996 covering the post-deregulation period. We excluded bonds from the analysis because of their high correlation of returns with those from ordinary shares. Figure 3 shows efficient frontiers for the two periods and it is immediately clear that the (nominal) rates of return and variability of return were very much higher in the earlier period. This is unsurprising given that the pre-deregulation period included years of high local inflation as well as turbulence in the international economy caused by such events as the oil price increases of the seventies.

Table 4. Maximum and Near-maximum Returns Portfolios; Pre- and Post-Deregulation

	Pre-Deregulation 1966 - 1984		Post-Deregulation 1985 - 1996	
	1	2	1	2
Composition (%)				
Shares	0.0	3.1	0.0	1.9
Farmland	100.0	96.9	100.0	98.1
Expected return (%)	7.8	7.7	6.0	6.0
Variance of return	253.4	225.3	183.3	171.9
Critical values of A*	0.00995		0.00823	

Table 4 shows the maximum expected return and immediately near-maximum expected return portfolios for the two periods. Farmland again dominates the maximum expected return portfolio, with small proportions of ordinary shares appearing in the immediately near-maximum expected return portfolios. The conclusion must be that deregulation made little difference to the appearance of ordinary shares or bonds in the high return portfolios. Furthermore if we investigate the impact of farmers' risk attitudes on these portfolios, it is observed that the critical levels of the coefficient of absolute risk aversion needed if the near-maximum expected return portfolios are to become utility maximising are well in excess of observations referred to earlier. Again, deregulation does not appear to have had any effect on optimal portfolios, taking into account what is known about New Zealand farmers' attitudes to risk.

Conclusion

This study has explored the potential reduction in risk from combining financial investments with farm assets. The results have shown that such combinations can lead to more stable rates of return. Negative correlation relationships between farm assets and financial investments found in this study indicate that significant risk reduction benefits could be obtained. However, when combined with information about farmers' attitudes to risk, we conclude that farmers are unlikely to adopt diversified portfolios with the aim of stabilising income. Our analysis may help to explain the empirical observations reported at the start of the paper.

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