DRIVERS OF RISK IN NEW ZEALAND DAIRY SYSTEMS

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ABSTRACT

Much research have been focused on the importance of physical parameters on the profitability of New Zealand pastoral systems, however not many efforts have been addressed from a financial perspective. As farms get bigger, the identification of the main drivers on farm economical viability becomes more important. The objective of this study was to identify important factors affecting Return on Equity (ROE) as a measure of risk in pastoral systems. A 5-years database of owner operated New Zealand dairy farms with seasonal milk supply pattern was analysed. A logistic regression model was used to examine the effects of several variables on ROE. The analysis was undertaken between farms and within seasons to account for the effect of milk payout on risk. The Debt to Asset Ratio, Operating Profit Margin and Asset Turnover Ratio were negatively correlated with risk and significant for the whole period analyzed. The Debt Servicing Capacity was positively correlated to risk and significant for the 5 years period; it was also the most dominant variable in determining the risk. The Farm Working Expense Ratio was positively correlated with risk however its significance level varied during the period analyzed. Effective Area was positive but not consistently correlated to risk. Thus improving economic efficiency and leverage (both amount of money borrowed and interest rates) are key issues to managing risk under New Zealand conditions.

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INTRODUCTION

Risk in dairy farming has rarely been addressed in New Zealand from the profit perspective. Much of the literature regarding profitability and viability of the dairy systems in New Zealand has been focused on the importance of cost control, through Farm Working Expenses, and the Operating Profit or Economic Farm Surplus (EFS). Both of these measurements have problems, since the first one includes only one side of the business (controlling costs) and the other,

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Operating Profit, does not include information that might be critical for the survival of the business. The use of the Rate of Return on Equity (ROE) has been utilized in some research to assess risk. ROE ranges from negative to positive values. Businesses with negative ROE are not covering at least a portion of their cost, and the more negative the ROE the greater is that portion, therefore at highly negative ROEs the owner's equity (without considering land appreciation) is being eroded at a faster rate than at lower negative values. High positive ratios of ROE are normally associated with profitable farm businesses, however it may also indicate an undercapitalised or highly leveraged farm business; on the other hand a low positive ratio that normally indicates an unprofitable farm business could also indicate a more conservative high equity farm business (Boehlje & Eidman, 1984; FFSC, 1997). As ROE considers the operating profit, the annual costs of leased capital (rent) and the annual cost of servicing the liabilities of the firm (interest), it is a more suitable indicator for profitability and viability of the business. The objective of this work is to identify the main variables affecting ROE, as a measurement of risk, and therefore give a clear idea about what is the impact of these variables on risk at the farm level.

Framework, Materials and Method

The analysis of the database followed a framework similar to that proposed by Langemeier & Jones (2001) where return on equity (ROE) is recognized as a good indicator of risk in agriculture. ROEs for each one of the five seasons included in the database were ranked in ten different categories. According to this criterion to classify risk, a category equal to 1 meant less risk than a category equal to 10. The use of the same range of ROE to determine the intervals for every season is consistent to determine risk and it allows comparisons between seasons as "comparing risk based upon different risk reference points … is undesirable if not erroneous and misleading" (Watts, Held, & Helmers, 1984, p. 177).

The database analysed in this study included from the 1998/1999 to 2002/2003 season. The total number of farms analysed was 1,026. These were owner operated, with seasonal milk supply and their Return on Equity (ROE) ranged from -40% to 40%. The analysis was conducted between farms and within each of the five seasons.

A logistic regression analysis (cumulative logit model), using the software Enterprise Guide® (SAS®), was used to examine the relative importance of factors affecting risk measured by the ROE ranking proposed above. The logit model uses odds and odds ratios to quantify the chances that an event will occur. Prior to running the model, all the variables to be included were standardized. The variables included in the regression were: Farm Working Expense Ratio, Debt to Asset Ratio, Operating Profit Margin, Asset Turnover Ratio, Debt Servicing Capacity, Effective Area and Economic Farm Surplus (Appendix). Some of these factors have been used in previous research to examine financial performance and risk (Langemeier & Jones, 2000, 2001; Purdy et al., 1997). The model was run predicting the probability of being in a higher category, which means a riskier position. The specific regression run for each of the five seasons can be stated follows:

$$(1) \quad \log [p_i/(1 - p_i)] = \alpha_0 + \beta_1 FWER_{i1} + \beta_2 DTAR_{i2} + \beta_3 OPM_{i3} + \beta_4 ATR_{i4} + \beta_5 DSC_{i5} + \beta_6 HA_{i6} + \beta_7 EFS_{i7}$$

where pi is the probability that risk category = 1,…,10; FWER is the Farm Working Expense Ratio, DTAR is the Debt to Asset Ratio, OPM is the Operating Profit Margin, ATR is the Asset Turnover Ratio, DSC is the Debt Servicing Capacity, HA is the Effective Area, EFS is the Economic Farm Surplus, i refers to an individual farm.

The Farm Working Expense Ratio (FWER) reflects the farm's ability to control expenses.

This ratio is calculated by dividing the total farm working expenses by the gross farm income. In this sense we expected that FWER would be negatively correlated with the proposed ranking of risk, especially at lower payouts.

The Principle of Increasing Risk states that the use of non-equity capital within a business has an asymmetric impact on it and the potential losses are far greater than potential gains. Debt to Asset Ratio (DTAR) reflects the basic leverage of the firm, therefore highly leveraged firms will be facing high risk. DTAR measures the risk-bearing ability of the firm as it is the capacity of the business to repay all financial obligations if all the assets were sold (Boehlje, 1994). We therefore expected a positive relationship between DTAR and the proposed ranking of risk.

Operating Profit Margin (OPM) and Asset Turnover Ratio (ATR) are the drivers of Return on Assets as is shown on the DuPont Financial Analysis System (Barnard & Boehlje, 1998-99; Boehlje, 1994). The former measures operating efficiency through revenue generation and cost control, whereas the latter is a measure of capital efficiency (Boehlje, 1994), therefore we expected a positive relationship between both of them and the proposed ranking of risk.

The Debt Servicing Capacity (DSC) measures the ability of a firm to service the commitments acquired through the money borrowed. It includes the annual interest payments plus the non-run off lease payments. As debt influences profitability through interest costs (Barnard & Boehlje, 1998-99), it was expected that those businesses with lower risk would have a lower Debt Servicing Capacity.

The effect of farm size was present through the inclusion of Effective Area (HA). Some researchers have found that as farms get bigger they would face less risk, therefore we expected a negative relation between farm size and risk. Purdy et al. (1997) found that mean financial performance (measured as Return On Equity) was "quite responsive to farm size". They also found that variability in financial performance is not affected by farm size, suggesting that there would be large benefits associated with increases in farm size.

The Economic Farm Surplus (EFS) or Operating Profit is a measure of the profit generated by a farm business, irrespective of both its funding or ownership structure. It is commonly used in New Zealand as a primary indicator of farm profitability, and it allows farmers to make comparisons with other similar farm businesses without giving too much personal information. However, while EFS has been recognised as one of a number of useful measures, alone it is an incomplete measure of farm profitability (Shadbolt, 1997).

RESULTS AND DISCUSSION

The Likelihood Ratio test statistic was highly significant (Chi-square < 0.0001) for each season, indicating that the variables as a group were a good indicator of risk measured through the categories of ROE proposed. The Odds Ratios, the Standard Deviations and the signs of the variables included in the logistic regression for each season are presented in Table 1; the Generalized R-square for each season analysed is also presented in the same table. The Odds Ratio represents the effect of the independent variable on the odds of the dependent one. The Generalized R-square measures the predictive power of the logistic model; finally the signs of the coefficients included in the model indicate the way the independent variables are correlated with the dependant one. The interpretation of Table 1 is as follows: the Odd Ratio of Asset Turnover Ratio (ATR) of 0.526 means that each increase of one Standard Deviation (4.22%), is associated with a 0.526 times decrease in the predicted odds of being in a more risky category.

For every season analysed, the Debt to Asset ratio (DTAR), Operating Profit Margin (OPM), Asset Turnover Ratio (ATR) and Economic Farm Surplus (EFS) were negatively correlated to risk measured as the categories of ROE. From these four variables DTAR, OPM and ATR were

Table 1. Odds ratios, signs and standard deviations of the seven variables included in the logistic model used to assess analyse the database

Season	1998/1999			1999/2000			2000/2001			2001/2002			2002/2003		
Payout[1]	3.58			3.78			5.01			5.35			3.66		
Variable	Correlation	Odds Ratio	Standard Deviation	Correlation	Odds Ratio	Standard Deviation	Correlation	Odds Ratio	Standard Deviation	Correlation	Odds Ratio	Standard Deviation	Correlation	Odds Ratio	Standard Deviation
Farm Working Expense Ratio	+	1.412	12.04%	+	2.551*	26.82%	+	1.085	12.47%	+	1.298	9.34%	+	1.229	12.83%
Debt to Asset Ratio	—	0.625**	25.51%	—	0.338*	20.88%	—	0.217*	20.38%	—	0.065*	18.70%	—	0.107*	23.42%
Operating Profit Margin	—	0.088*	13.37%	—	0,012*	14.67%	—	0.009*	16.54%	—	0.004*	9.51%	—	0.008*	14.23%
Asset Turnover Ratio	—	0.526*	4.22%	—	0.189*	5.64%	—	0.089*	9.96%	—	0.023*	5.36%	—	0.258*	5.60%
Debt Servicing Capacity	+	13.285*	10.81%	+	91.762*	22.47%	+	41.512*	10.48%	+	46.203*	6.89%	+	87.087*	9.86%
Effective Area	+	1.525**	51.65 ha	+	1.085	54.41 ha	+	1.482	67.97 ha	—	0.969	57.80 ha	+	1.206	78.73 ha
Economic Farm Surplus	—	0.628	$36,391	—	0.427**	$65,473	—	0.284	$112,923	—	0.870	$107,134	—	0.534**	$66,306
Generalized R-square	75.42%			89.59%			71.29%			82.26%			87.95%		

1 Seasonal payout in nominal NZ$ per kilogram of milk solid
** Significant at the 1% level
** Significant at the 5% level

significant in the logistic model for the five seasons included in the analysis. The Farm Working Expense Ratio (FWER) and Debt Servicing Capacity (DSC) were positively correlated to risk, but only for the latter were there significant correlations for all five years. Effective Area did not have a consistent correlation with risk, neither with its sign nor with its level of significance. The results to be presented are only for those variables that were found significant (DTAR, OPM, ATR and DSC).

As shown in Table 1, the most powerful variable associated with risk for the current research was the Debt Servicing Capacity (DSC). As DSC in the current database included mainly interest payments (90%), this indicates that those farmers with a higher proportion of their GFI being used to service debt (high interest payments and low levels of GFI) are more likely to face high risk levels than those whose proportion of GFI to paid debt is less (with low interest payments and high GFI). However there is an interesting interaction to consider on this point, as the Debt to Asset ratio (DTAR) was found to be negatively correlated to risk during the whole period analysed. Although Langemeier & Jones (2001) found in their analysis that DTAR was positively correlated with risk, and thus higher levels of debt would mean more risk for the farmers, Purdy et al. (1997) also found that DTAR was negatively correlated to the mean of ROE but positively correlated to its variation. The average DTAR for the present research and for that of Purdy et al. (1997) were slightly higher than the average for Langemeier and Jones's (2001) (35.69%, 32.82% and 30.56% respectively) and all of them had a standard deviation of about 22%, thus the difference in the results between the studies could be explained by a low level of debt for the sample of Kansas farmers analysed by Langemeier & Jones (2001). In other words the present research, and that conducted by Purdy et al. (1997), have confirmed that when non-equity capital is used efficiently and return on assets is greater than the interest rate, highly leveraged farms would increase their ROEs sharply and therefore they would be facing less risk than those with lower levels of debts as they would be able to increase their rates of business growth . Under the Principle of Increasing Risk described by Boehlje & Eidman (1984) this situation is absolutely consistent with that described. The use of leverage is

also explained by Gloy & Baker (2002) as they state that the use of different levels of leverage influences the strategies to be adopted: "…financial leverage can be used to increase the mean return of strategies that contain a relatively small amount of business risk". Therefore the efficient use of non-equity capital is one of the best ways to increase the financial performance of the business; however it is also one of the easiest routes to bankruptcy.

The fact that Operating Profit Margin (OPM) and Asset turnover ratio (ATR) were negatively correlated to risk was not surprising as the DuPont Financial Analysis System described by Boehlje (1994) and Barnard & Boehlje (1998-99) show that both OPM and ATR are the drivers of return on assets (ROA) which in turn is one of the drivers of return on equity (ROE). Similarly, Purdy et al. (1997) found that financial efficiency was negatively related to financial performance (ROE). Therefore the profitability of the systems, measured as the return per dollar of gross farm income (OPM), and the efficient use of farm assets to generate revenue (ATR) are also highly important to ensure long term viability of the farm business.

Risk Categories

According to their level of ROE, for all the five seasons analysed, three risk categories were created: High Risk Group (HRG), Medium Risk Group (MRG) and Low Risk Group (LRG). As the ROEs for each farm of the database were grouped into 10 categories; the average of the ROE's categories was then calculated for each season analysed. The HRG was created by adding one standard deviation to the average of the ROE's category estimated for each season of the database. Similarly, the LRG was created by subtracting one standard deviation to the average of ROE's category estimated for each season from the database. As expected the percentage of farms in the LRG was higher in the two years with the higher payout (2000/2001 and 2001/2002). The opposite happened with the HRG, as Figure 1 shows.

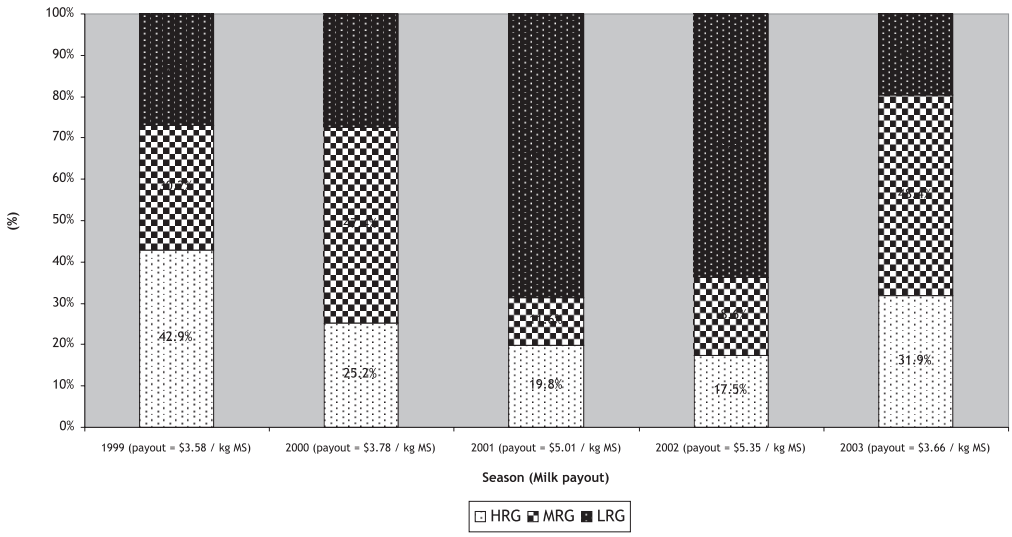

Figure 1. Percentage of farms in the High Risk Group (HRG), Medium Risk Group (MRG) and Low Risk Group (LRG) for each season analyzed

In general terms as dairy farms have little or no chance to diversify the business, milk payout is one of the main drivers of gross farm income which in turn has a big effect on farm profitability. During the first four seasons analysed in this study, the increases in payout were 5.6% (1998/1999 - 1999/2000), 32.5% (1999/2000 - 2000/2001) and 6.8% (2000/2001 – 2001/2002)

(in real terms). Therefore, the proportion of HRG farms decreased steadily (42.9%, 25.2%, 19.8% and 17.5% respectively), on the contrary the proportion of farms facing low levels of risk increased sharply (from 27.4% to 68.5%) when payout had its largest increase (32.5%). Finally it is important to notice that when the milk price dropped to $3.66/kg of MS (2002/2003 Season), the proportions of farms in each group returned to a distribution that was similar to the distribution that had existed before milk prices increased.

DESCRIPTION OF THE THREE RISK CATEGORIES

The three risk category groups created (HRG, MRG and LRG) were described according to the variables found to be significant in the logistic model proposed. For each season, analysis of variance (One-way ANOVA) and Bonferroni tests were carried out to assess the differences in the means of the variables included.

The HRG had the highest Debt to Asset Ratio (DTAR) for the first two seasons (46% and 44% for 1998/1999 and 1999/2000 respectively) (Figure 2). For the same two seasons, the levels of debt were no different between the LRG and MRG farms. However, when payout increased in the season 2000/2001 the only group that increased their DTAR was the LRG (from 36% to 40%). The LRG stayed at about 40% in the level of debt and these were the highest values of DTAR during the next three years. The Debt Servicing Capacity (DSC) presented its lowest values in the LRG for each of the five seasons (Figure 2). Conversely, the HRG had always the highest value of DSC with average values around 20%. Despite the differences found in the DTAR between the three groups, the DSC was similar for LRG and MRG farms during the whole period analysed, and these two groups differed of the HRG during the five years.

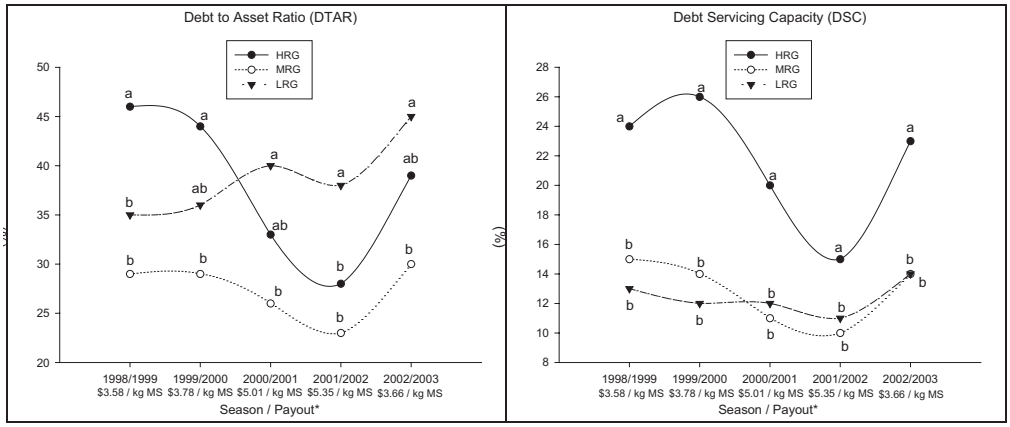

Figure 2. Debt to Asset Ratio (DTAR) and Debt Servicing Capacity (DSC) for the High Risk Group (HRG), Medium Risk Group (MRG) and Low Risk Group (LRG) for each season[1]

[1] different letters indicate significant differences between the groups within a season at the 5% level

As shown in Figure 2 Debt to Asset Ratio (DTAR) for the HRG farms was very changeable during the five seasons analysed (Figure 2). When payout was over $5/kg MS this group decreased its DTAR, probably because with higher gross farm incomes they were able to repay some of their financial commitments. However by the time payout dropped to $3.66, the average level of debt in this group was again at similar levels as those presented by the LRG. On the contrary, as milk price increased, the LRG increased its average levels of debt, reaching even greater levels of debt than the HRG. This situation can be explained by the fact that the farmers

of the LRG took strategies with less production risk, such as the use of supplements or others, so allowing them to take more financial risk, as described by Gloy & Baker (2002). Instead of undermining their chances to be more profitable through a reduction in their levels of debt, these farmers increased DTAR in order to capture the benefits of high payouts through the use of non-equity capital. The MRG had the lowest values of DTAR through out the whole period analysed, which probably reflects farmers who are very conservative in their financial management.

Although the HRG had the highest DTAR in the first two seasons and LRG had the highest values of DTAR in the last three seasons, the Debt Servicing Capacity (DSC), which is the proportion of the GFI used for interest payments, was always statistically higher for the HRG than both the LRG and the MRG. The increases in DSC can be explained in three ways: (1) an increase in gross farm income either by an increase in volume produced or in milk price or, (2) a decrease in the annual interest payments (interest rates and levels of debts) or, (3) a combination of both. The reduction of DSC for the HRG during the two seasons with the highest payouts can be explained mainly by the increase in gross farm income (GFI) due to higher milk payout; but also the lower levels of debt and hence interest payments. Finally, as already explained, a combination of both of these reasons may have been used to reduce DSC. Both LRG and MRG had significantly lower levels of DSC than HRG during the whole period analysed, which was expected since MRG had lower levels of debt than the HRG. However as the LRG had even greater DTAR than HRG, the difference in DSC is explained by a greater GFI generated by the LRG than the HRG, this explanation was further reinforced when the Asset Turnover Ratio (ATR) was analysed. This situation reflects the differences in financial management and the relation between level of debt and profitability of the HRG and LRG.

The Operating Profit Margin (OPM) was consistently different for the three groups during the time span analysed (Figure 3). The highest values of OPM were present in the LRG for every season, and each time those values were higher than 30%. As payout increased from the season 1999/2000 to 2000/2001 so did it OPMs' values for every group. However when milk payout dropped again in the season 2002/2003 OPMs went downward. The Asset Turnover Ratio (ATR) was always higher in the LRG farms (Figure 3). Despite the fact that OPM was different between the three risk groups in each of the five seasons analysed, the HRG and MRG farms did not differ in their ATR values for any of the years. Nevertheless, the LRG farms were different from the other two groups in four of the five seasons included in the analysis.

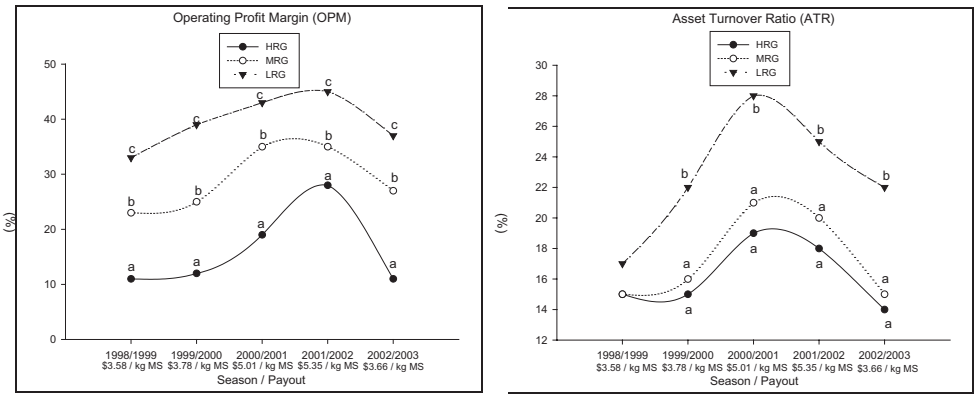

Figure 3 Operating Profit Margin (OPM) and Asset Turnover Ratio (ATR) for the High Risk Group (HRG), Medium Risk Group (MRG) and Low Risk Group (LRG) for each season[1]

[1] different letters indicate significant differences between the groups within a season at the 5% level

Both OPM and ATR had similar patterns. As expected, the higher the payout the more profitable all the groups were, as a bigger proportion of the gross farm income was captured as operating profit or economic farm surplus (EFS). The OPM indicated that although MRG were more efficient in revenue generation and cost control than HRG farms, LRG farms were much more efficient than both MRG and HRG farms for every season analysed. Despite the fact that the increases in OPM for the HRG during the seasons 1999/2000 to 2000/2001 and from this to 2001/2002 were greater than the increases of LRG for the same seasons (+7% and +9% for HRG and +4% and +2% for LRG), the OPM of the HRG in the last season dropped by -17% when payout went back to $3.66/kg MS, whereas the LRG dropped only 8%. This situation highlights the stability of the operating efficiency of the farmers in the LRG. On the other hand, the capital efficiency of the farms measured through the ATR showed that, although for the first season analysed there were no differences between the three risk groups, during the last four seasons of the analysis there were significant differences between HRG and MRG compared with LRG. No differences were found in ATR between the LRG and MRG, but they did differ in their OPM, reflecting that although both groups can be equally efficient in using farm's assets to generate revenue, differences exist between them in terms of their returns per dollar of gross farm income. High management skills are highlighted in the LRG, since they are not only able to be profitable but they achieve this by trying to optimise the combination of resources used in the production process.

The ability to manage debt according to milk payout (DTAR), the lower proportion of interest payment over gross farm income (DSC), the high efficiency achieved by the system measured as the proportion of operating profit over the gross farm income (OPM) and the high efficiency in generating income from the farm's assets (ATR), resulted in the LRG having the highest return on equity of all the three groups.

Finally, as expected, the Return on Equity (ROE) was significantly different between the three groups within each of the five season analysed (Figure 4-30). As payout increased, ROE also increased and, as expected, the LRG farms had the highest values of ROE for every sea-

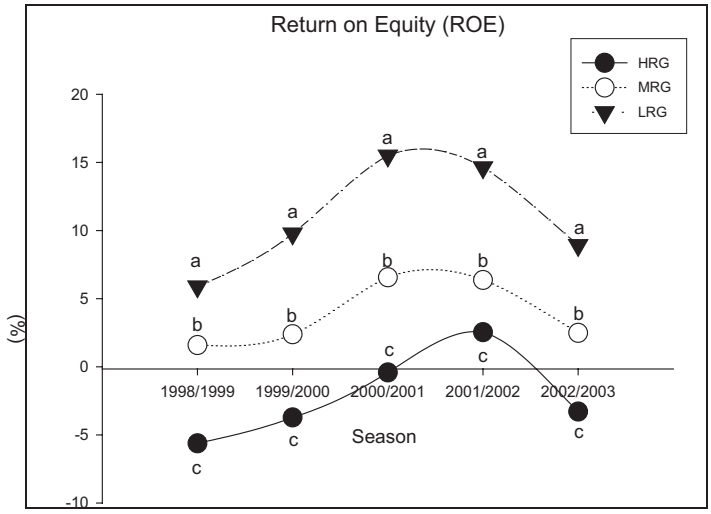

Figure 4 Return on Equity (ROE) for the High Risk Group (HRG), Medium Risk Group (MRG) and Low Risk Group (LRG) for each season[1]

[1] different letters indicate significant differences between the groups within a season at the 5% level

son. The only season HRG farms could get a positive ROE was at the highest payout (season 2001/2002, $3.78/kg MS), nevertheless the difference between the average ROE of LRG and HRG was always greater than 10%.

CONCLUSION

The current research has showed that in the sample of dairy farms used, risk was closely related to the relationship between the interest payments and the gross farm income of the business (Debt Servicing Capacity). As this ratio increased, the risk faced by a farm increased as well; this also explains the fact that why rural lenders in New Zealand put a lot of emphasis on this measure. Another association between debt levels and risk was shown by the relationship between the farm's liabilities and assets (Debt to Asset Ratio). Contrary to expectations, increased debt was negatively related to risk, which can be explained by the Principle of Risk Increasing. Therefore through the combination of efficient use of non-equity capital and levels of Return on Assets greater than the interest rates at which the money is being borrowed, highly leveraged farms can increase their ROEs sharply; as a consequence, they would reduce their levels of risk in terms of their long-term survival. The results also showed that as both capital efficiency (Asset Turnover Ratio) and operating efficiency (Operating Profit Margin) increased, there was a reduction in risk, as measured by the Return on Equity. This was expected as both of these ratios are drivers in the Dupont model.

The analysis of the three risk groups created (HRG, MRG and LRG) showed that differences between them in their debt management, their operating and capital efficiencies were the most distinguishing features between the groups. The efficient use of non-equity capital (debt levels) and the ability to capture the benefits of external factors (e.g. increases in payout) through increases in both operating and revenue generation efficiencies are the determinants of risk (measured as Return on Equity). Against expectations and other researchers' results, there was no effect of farm size on ROE in the database analysis. Finally, the analysis of the database has also highlighted the limitations in using EFS as the only measurement of profitability in dairy systems, as well as identifying the fact that the Operating Profit Margin is a better indicator of cost control than Farm Working Expense Ratio.

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APPENDIX 1

- Return on Equity (ROE)
  - ROE = (EFS – Other Rent – Interests Payments) ÷ (Owner's Equity)
- Owner's Equity (OE)
  - OE = (Total Assets) – (Total Liabilities)
- Economic Farm Surplus (EFS)
  - EFS = (Gross Farm Income) – (Operating Expenses)
- Farm Working Expense Ratio (FWER)
  - FWER = (Farm Working Expenses) ÷ (Gross Farm Income)
- Debt to Asset Ratio (DTAR)
  - DTAR = (Total Farm Liabilities) ÷ (Total Farm Assets)
- Debt Servicing Capacity (DSC)
  - DSC = (Interest payments + Other Rent) ÷ (Gross Farm Income)
- Operating Profit Margin (OPM)
  - OPM = (Economic Farm Surplus) ÷ (Gross Farm Income)
- Asset Turnover Ratio (ATR)
  - ATR= (Gross Farm Income) ÷ (Total Farm Assets)