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Dairying regions in Victoria: Risk profiles using historical data and @RISK®

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Abstract

The paper asks, "***What comparisons of farm financial risk characterise the key Victorian dairy regions over the past 13 years?***" The dairy industry is the 3rd largest rural industry in Australia (Dairy Australia, 2018). The dairy farmers, though, are facing a continuous cost price squeeze amid a challenging global environment that suppresses milk prices and raises feed costs in the face of drier and hotter weather conditions (Dairy Australia, 2019). For this analysis, we focused on three key Victorian dairy regions, namely North (**N**), Gippsland (**G**) and South West (**SW**) which have a combined share of 67% in Australia's milk production (Agriculture Victoria and Dairy Australia, 2018).

We analysed the financial risks of these regions based on a representative farm from each region. Balance sheet, profit and loss budget and cash flow were integrated (Malcolm, Makeham, & Wright, 2005) to create a probabilistic model using @RISK version 7.6 from Palisade (2018). The variability in historical inputs of dairy prices, quantities and costs for thirteen years from 2006-07 to 2018-19 in Victorian dairy regions (Agriculture Victoria and Dairy Australia, 2019) was captured using a multivariate copula in @RISK. We, thus, generated decadal (10-year) distributions of profit and loss budgets, balance sheets and cash flows to simulate risks with one hundred thousand iterations under Monte Carlo method.

The simulation showed that the net farm income was positive 55, 70 and 80 percent of decades respectively for farms in North, Gippsland and South West regions.

Sensitivity analysis of the variable components of income, production and cost and their contributions to variance in net farm income showed that the price of milk was the largest source of variation in net farm income for all regions. Variations in feed costs were greatest in the North region compared to the other two. At the close of a decade (year 10), South West region outperformed on all accounts, including debt repayments, building/retaining equity, return of capital (ROC) and return on investment (ROE) and, thus, appeared the most viable for dairying.

The business and financial risk for dairy farms based on variability in production, prices and costs was captured in this analysis by using historical data. We extended its usefulness through @RISK by illuminating their recent probabilistic risk profiles. The method allowed us to summarise the long-term portfolios of farm net profits, debt management and key performance indicators of ROC and ROE. There is a need to extend this analysis to capture the shortages and rising costs of water, particularly in the Northern region.

KEYWORDS: Risk, Farm financial planning, Dairy, @RISK®

Objective or research question

What comparisons of farm financial risk characterise the Victorian dairy regions over the past 13 years?

Background

Australia's dairy industry is country's 3rd largest rural industry with a farmgate value of A$4.3 billion in financial year 2017/18. Australia's 5,699 dairy farms produce 9.3 billion litres of milk annually (Dairy Australia, 2018). The dairy farmers are facing a continuous cost price squeeze amid a challenging global environment that suppresses milk prices, raises feed costs with drier and hotter weather conditions (Dairy Australia, 2019). For this analysis, we chose the state of Victoria with its 3,520 dairy farms in 2018-19 producing 5.57 billion litres of milk (Agriculture Victoria and Dairy Australia, 2018), which is 67% of Australia's milk production[1]. This analysis focused on the Victorian dairy regions of North (N), Gippsland (G) and South West (SW) and compared their financial risks.

Methods

For managing any business, including a farm, the liquidity, efficiency and wealth are pivotal and are interlinked.

i. Liquidity (Cash) is cash flow management to ensure more cash comes into the business than goes out. Good cash flow management means the firm has enough cash to meet the day-to-day running of the business when annual costs vary from year to year.
ii. Efficiency (Profit) captured in Profit and Loss budgets reveals whether the business makes enough profit, after all, expenses and gives a positive return on the capital being managed.
iii. Wealth (Net worth) is reflected in the Balance sheet that measures how business wealth grows over the years. It is a snapshot in time showing changes in assets and liabilities over a whole year. It compares the firm's net worth at the beginning of the year to the net worth at the end of the year.

[1] Dairy Australia milk production report Sept 2019 https://www.dairyaustralia.com.au/industry/production-and-sales/latest-production-and-sales-statistics

The methods section presents the steps that included the integration of balance sheet, profit and loss budget and cash flows along with @RISK version 7.6 from Palisade (2018) for this analysis:

Step I: Opening and closing balance sheets for decadal cash flows
Step II: Profit and loss budget using historical production, price and cost data correlating it for multivariate analysis with @RISK
Step III: Cash flows
Step IV: Financial ratios as key performance indicators (KPIs)

Step I. Opening and closing balance sheets for decadal cash flows

An opening balance sheet captured net worth on an average representative farm[2] in each of the three regions of Victoria. The balance sheet provided a 'bottom line' of opening values for 2018-19 against which to measure the growth of business wealth across the next ten years. The assets and liabilities were based on the Agriculture Victoria and Dairy Australia (2019) published data for Victorian dairy regions of North, Gippsland and South West[3] (Figure 1).

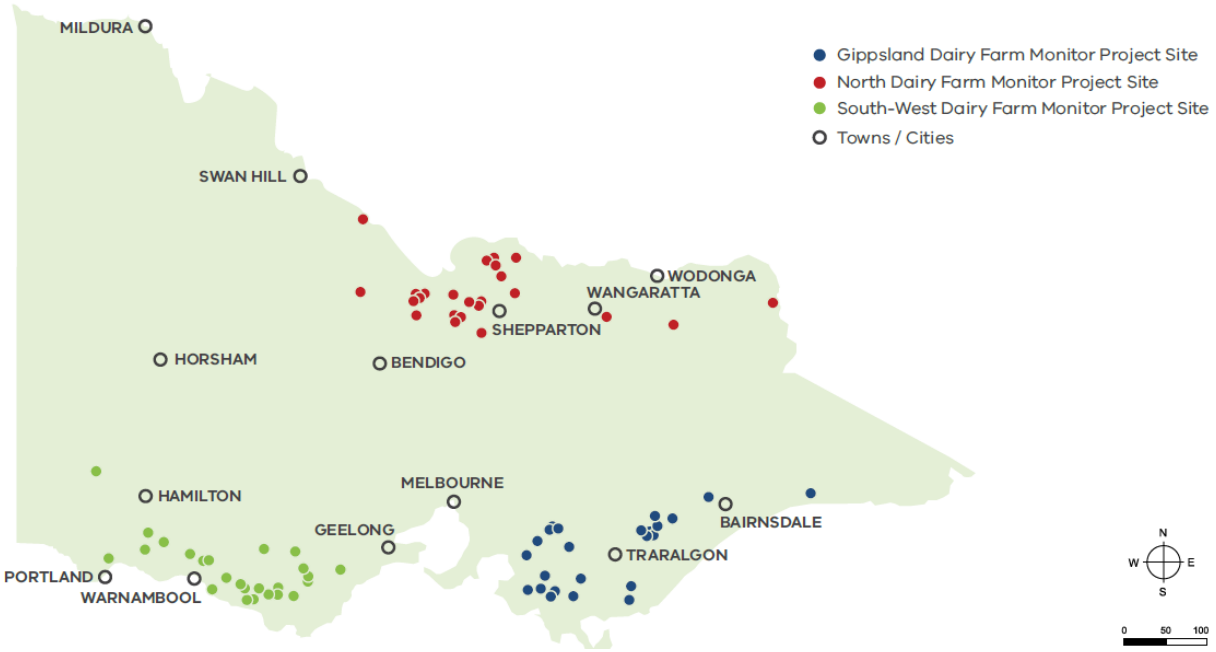

Figure 1: Map of Dairying regions in Victoria including Gippsland
Source: Dairy Australia

The growth or decline in assets or liabilities was based on risk captured in the profit and loss budgets linked to the balance sheet to obtain an opening/closing balance for each of the ten years (decades) simulated in our analysis (Step II). We assumed the liabilities to be debt

[2] Dairy Farm Monitor project annual report(s) had 25 sample farms for each region of the three dairying regions. The data captures the economic, financial and bio-physical aspects of these farms for the last 13-years.
3 Asset and liability values in dollars per hectare were multiplied by average hectares for 2018-19

financed by a bank overdraft facility to meet the farm's payment obligations[4]. From the balance sheet, we generated risk profiles that may be described as cumulative distribution functions (CDFs) showing the probabilistic nature of growth or decline in equity. Net worth or owners' equity in the farm was calculated as follows:

$$Net\ worth = Total\ assets - Total\ liabilities$$

Step II. Profit and loss budget using historical production, price and cost data and correlating the data for multivariate analysis with @RISK

The variability in dairy farm milk prices and income from all sources, production and costs for thirteen years, i.e. from 2006-07 to 2018-19 in these three Victorian dairy regions was captured using the data from Agriculture Victoria and Dairy Australia (2019). The annual profitability was then measured using a Profit and Loss budget using a farm business growth method by Malcolm, Makeham, and Wright (2005)[5].

As the aim was to simulate the future, based on the past data, a multivariate copula was used to mirror reality more closely. The marginal distributions of deterministic inputs of historical prices (P), quantities (Q) and all costs from 2006-07 to 2018-19 were combined to form the multivariate distribution using a copula to capture the means, variances and covariances in the data (Hardaker, Lien, Anderson, & Huirne, 2015). All the copula parameters were estimated from the historical data using @RISK version 7.6 (Palisade, 2018). The copula type was chosen using the maximum likelihood method. The multivariate distribution was used to drive the simulations. We generated decadal (10-year) distributions of profit and loss budgets and cash flows by performing one hundred thousand iterations of the Monte Carlo simulation. In each iteration, the gross revenues, production and costs were simulated using the estimated multivariate distribution.

Step III. Cash Flows

Cash flows are of prime interest to the business and were captured by adding back depreciation to the net farm income[6].

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4 Two step method:
i) Check IF (Net farm income<0, give 0, otherwise 1)
ii) Debt Accumulation IF (Check=0 i.e. a deficit year or negative farm growth in Equity, Overdraft to pay the deficit, otherwise debt from previous year to carry forward & partially repaid by equity growth)

5 Same method has been applied by Agriculture Victoria and Dairy Australia. *Dairy Farm Monitor Project Victoria Annual Report 2018-19* methods chapter provides a detailed explanation.

6 Cash flows is defined as earnings after tax plus depreciation. For this data however, the tax was neither deducted nor added since it was not provided in the data source i.e. *Dairy Farm Monitor Project Victoria Annual Report 2018-19*. The report described net farm income as follows:
Net farm income = Earnings before interest and tax (EBIT) minus interest and lease costs. The amount of profit available for capital investment, loan principal repayments and tax.

Step IV. Financial ratios as key performance indicators (KPIs)

Solvency

To gauge whether the farm can withstand economic downturns based on the owner's financial commitments, we used the solvency ratio of equity to assets, expressed as a percentage. It was calculated from the balance sheet by dividing the farm owner's total equity by the total assets managed to represent the amount of assets on which the owners had a residual claim.

$$Equity\ to\ assets\ ratio = \frac{Total\ farm\ Equity}{Total\ farm\ Assets} \times 100$$

Profitability:

Profit does not indicate economic efficiency until it is related to the amount of capital used to produce it.

Return on assets (ROA) assesses a firm's efficiency at allocating all the capital resources under its control to generate returns.

$$Return\ on\ capital\ managed\ (ROC)\% = \frac{Operating\ profit\ or\ EBIT}{Total\ assets\ managed} \times 100$$

Whereas, return on owner's equity (ROE) provides an estimate of the return in relation to capital invested by the owners.

$$Return\ on\ owner's\ equity\ (ROE)\% = \frac{Net\ \ profit\ before\ tax\ (NPBT)\ OR\ net\ farm\ income}{Total\ Equity} \times 100$$

These performance indicators (KPIs) were reported for year opening and closing balances.

Results

Net farm income was positive 55, 70 and 80 percent of decades, respectively for farms in North, Gippsland and South West regions (Figure 2).

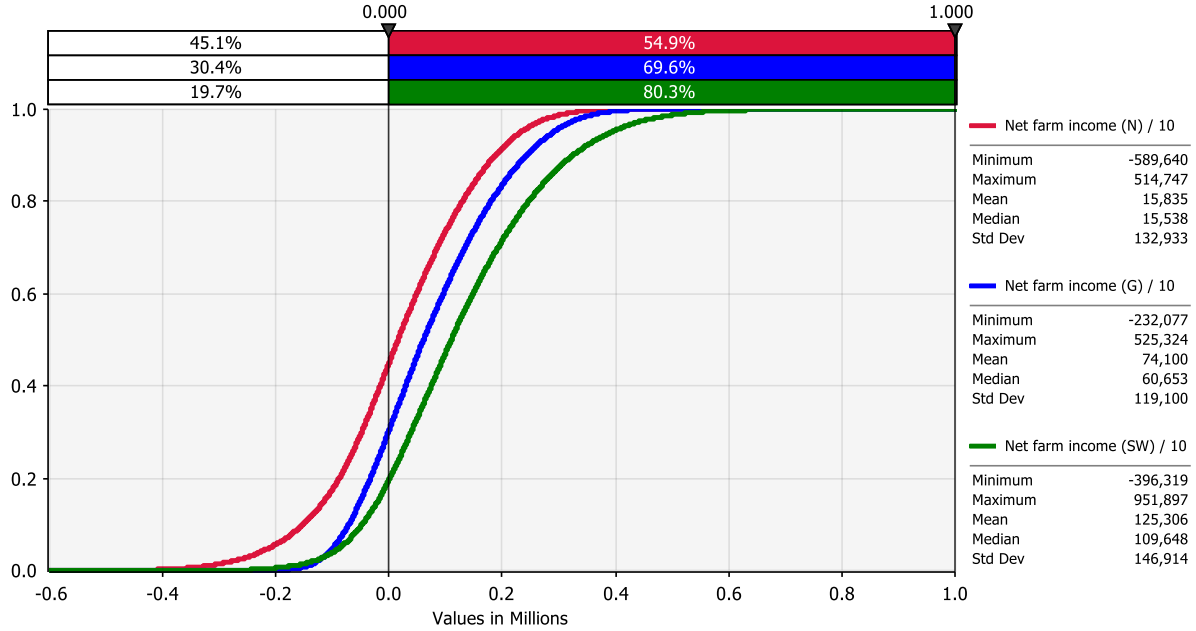
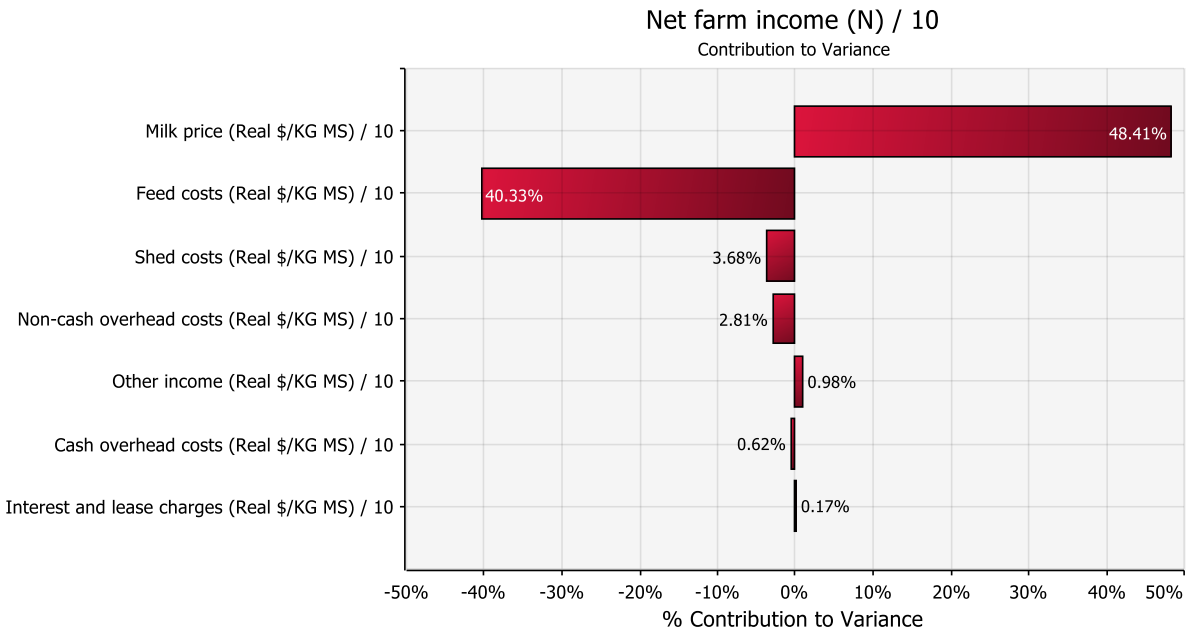
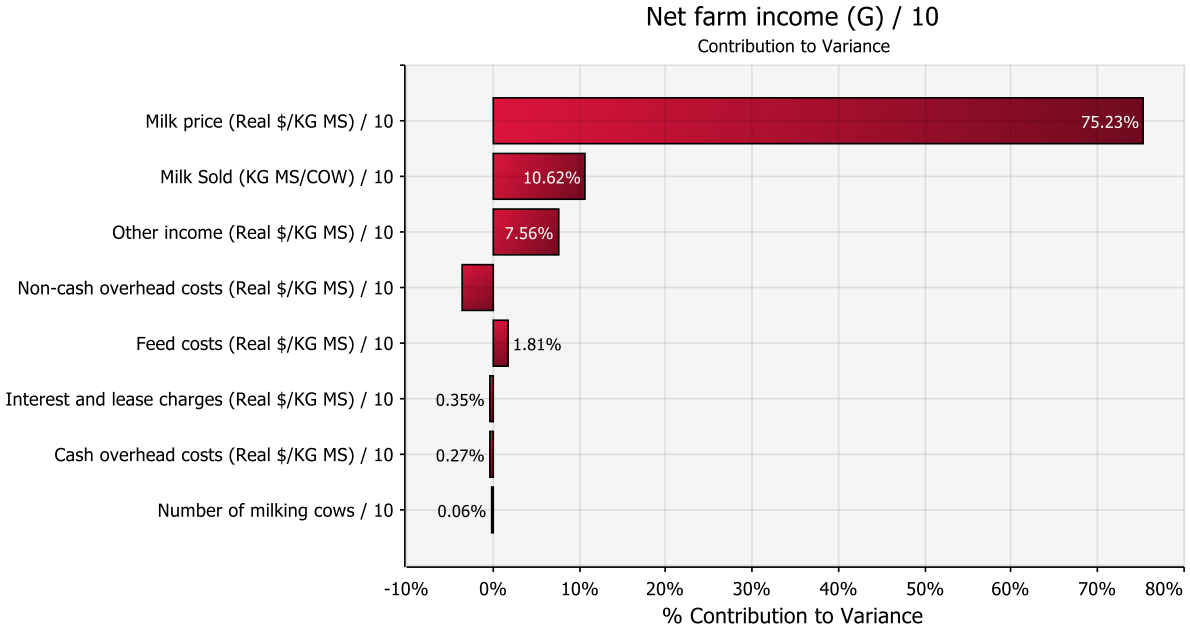


Figure 2: Cumulative frequency distributions of net farm income risk profile for dairy farms in North, Gippsland and South West regions of Victoria (year 10)

Sensitivity analysis using tornado graph of contribution to variance[7] towards net farm profit (Figure 3) showed that the price of milk was the key input variable responsible for large variations in net farm profits as an output. Feed costs, milk sold, and non-cash overhead costs were the second major input variables responsible for these variations in North, Gippsland and South West dairy regions of Victoria respectively.

[7] For tornado graphs showing Contribution to Variance, the length of the bar shown for each input distribution is the amount of change in the output attributable to each input.


Net farm income (N) / 10
Contribution to Variance
Milk price (Real $/KG MS) / 10
Feed costs (Real $/KG MS) / 10
Shed costs (Real $/KG MS) / 10
Non-cash overhead costs (Real $/KG MS) / 10
Other income (Real $/KG MS) / 10
Cash overhead costs (Real $/KG MS) / 10
Interest and lease charges (Real $/KG MS) / 10
48.41%
40.33%
3.68%
2.81%
0.98%
0.62%
0.17%
-50% -40% -30% -20% -10% 0% 10% 20% 30% 40% 50%
% Contribution to Variance


Net farm income (G) / 10
Contribution to Variance
Milk price (Real $/KG MS) / 10
Milk Sold (KG MS/COW) / 10
Other income (Real $/KG MS) / 10
Non-cash overhead costs (Real $/KG MS) / 10
Feed costs (Real $/KG MS) / 10
Interest and lease charges (Real $/KG MS) / 10
Cash overhead costs (Real $/KG MS) / 10
Number of milking cows / 10
75.23%
10.62%
7.56%
1.81%
0.35%
0.27%
0.06%
-10% 0% 10% 20% 30% 40% 50% 60% 70% 80%
% Contribution to Variance

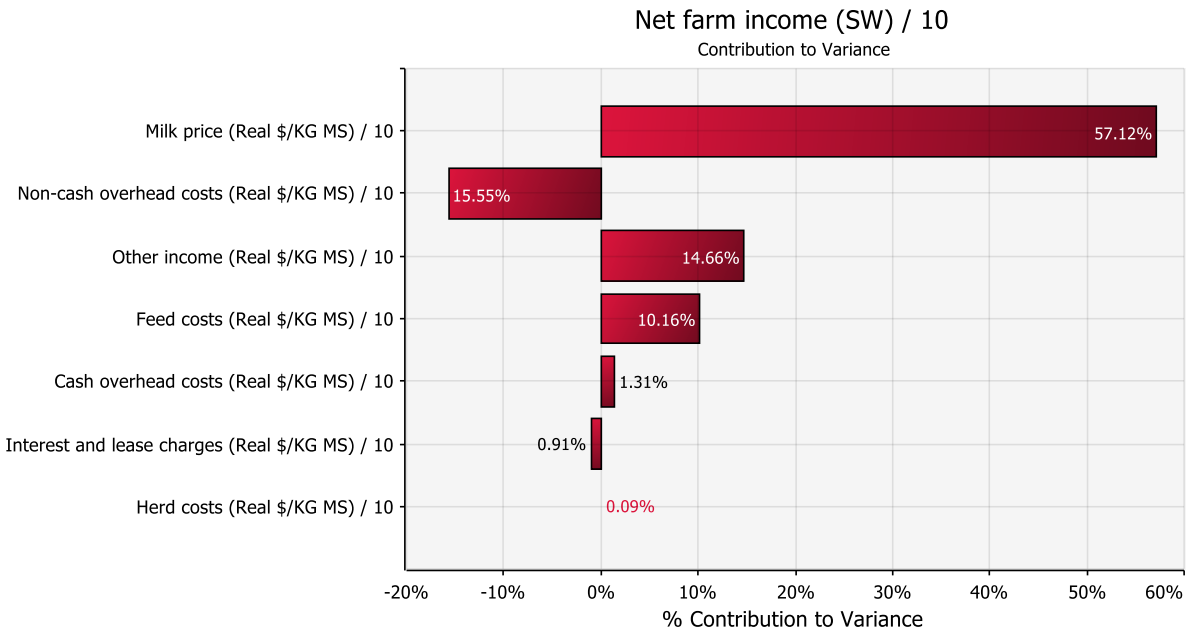


Figure 3: Price, quantity and cost input variables ranked by contribution to farm's net income variance in North (top), Gippsland (middle) and South West (bottom) regions of Victoria

Financial ratios as key performance indicators (KPIs)

Based on an average opening debt per farm of 1.82m, 1.54m, and 1.87m in North, Gippsland and South West regions of Victoria respectively at the close of a decade (year 10) the farms had a median debt of 3.21m, 2.07m and 2.03m respectively (Figure 4). The opening equity per farm was 67%, 69%, and 66% in North, Gippsland and South West and closed at a median of 42%, 58% and 63% respectively.

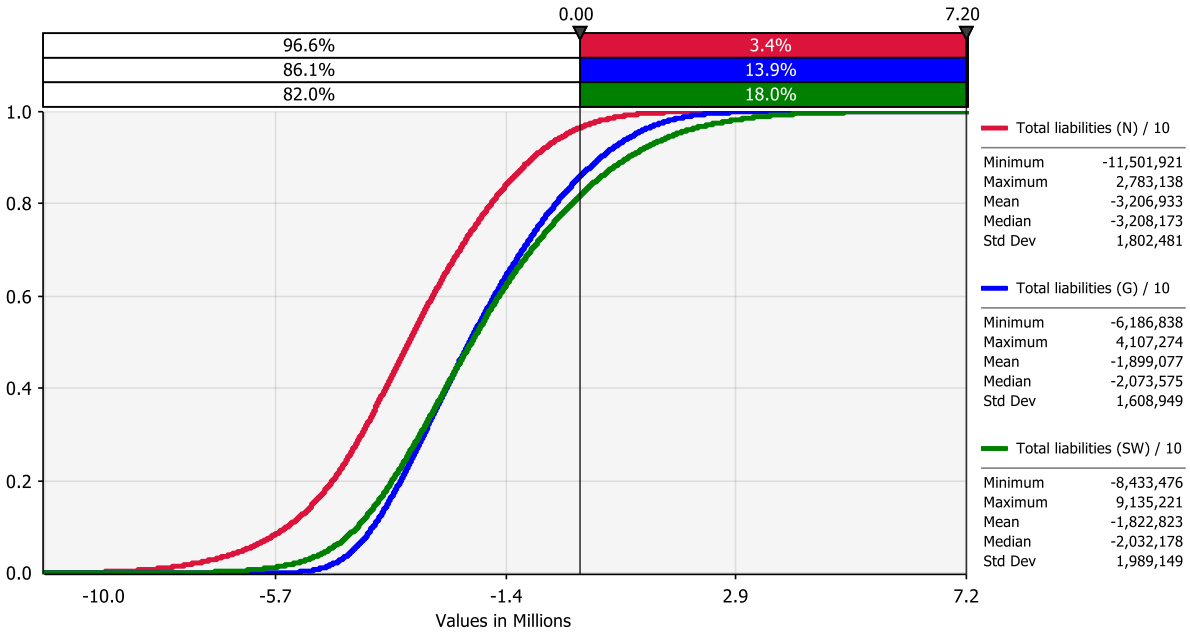


Figure 4: Cumulative frequency distributions of decadal changes in liabilities or debt for farms in the North, Gippsland and South West regions of Victoria

Table 1 shows that the North region was lowest and South West highest on both accounts of ROC and ROE.

Table 1: Summary statistics of the decadal return on capital (ROC) and equity (ROE) for farms in North (N), Gippsland (G) and South West (SW) regions of Victoria

Return on Capital (ROC) and Return on Equity (ROE) (region in parenthesis)	**Mean**	**Median**	**5% Quantile**	**95% Quantile**
ROC (N)	1.68%	1.29%	-0.87%	5.69%
ROC (G)	2.77%	2.25%	0.03%	6.49%
ROC (SW)	4.08%	3.62%	0.71%	8.10%
ROE (N)	-21.01%	0.64%	-50.84%	4.44%
ROE (G)	-5.68%	2.07%	-12.99%	4.82%
ROE (SW)	-3.13%	3.17%	-10.73%	5.38%

Discussion and conclusion

Farming is a risky business and the variability in production, prices and costs that impact profitability was captured in the whole farm business analysis using @RISK (Palisade, 2018) and Victorian Dairy Farm Monitor project data.

@Risk facilitated the breakdown of price, quantity and costs that impacted farm profitability (Figure 2) and projected how the next ten years could pan out for the regions. Variations in milk price (Figure 3) had the largest impact on all regions. However, the second factor varied for each region. The farm with different opening debts in all three regions started with different opening debts, but South West regions outperformed all other regions in retiring the debt and maintaining equity (Figure 4) and generating returns on capital (ROC) and equity (ROE) (Table 1).

The risk for three dairying regions in Victoria based on variability in production, prices and costs was captured in this analysis by using historical data with @RISK. The method used is powerful as it summarizes the long-term portfolios of net farm profits and extends the usefulness of the past data by illuminating the likely financial risk profiles with the farmer's management information. South West is most viable for dairy farming, but there is a need to extend this analysis further to gauge the impact of shortages and rising costs of water, particularly in the of Victoria's North region.

Acknowledgements

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References

Agriculture Victoria and Dairy Australia. (2018). *Dairy Farm Monitor Project Victoria Annual Report 2017-18* Melbourne: Dairy Australia Retrieved from https://www.dairyaustralia.com.au/farm/farm-business-management/dairy-farm-monitor-project.

Agriculture Victoria and Dairy Australia. (2019). *Dairy Farm Monitor Project Victoria Annual Report 2018-19*. Melbourne: Dairy Australia Retrieved from https://www.dairyaustralia.com.au/farm/farm-business-management/dairy-farm-monitor-project.

Dairy Australia. (2018). *Australian Dairy Industry In Focus 2018*. Southbank VIC: Dairy Australia Limited Retrieved from https://www.dairyaustralia.com.au/DairyAustralia/About-Dairy-Australia/About-the-industry/In-Focus?keyword=Australian%20Dairy%20Industry%20In%20Focus%202018.

Dairy Australia. (2019). *Dairy Situation and Outlook October 2019*. Southbank VIC: Dairy Australia Limited. Retrieved from https://www.dairyaustralia.com.au/industry/dairy-situation-and-outlook/situation-and-outlook-february-2019.

Hardaker, J. B., Lien, G., Anderson, J. R., & Huirne, R. B. M. (2015). *Coping with Risk in Agriculture* Retrieved from http://www.cabi.org/cabebooks/ebook/20153137229

Malcolm, B., Makeham, J., & Wright, V. (2005). *The farming game: Agricultural management and marketing* (2nd ed.). Melbourne: Cambridge University Press.

Palisade. (2018). @RISK, Decision Tools Suite 7.6. Palisade Decision Tools, Ithaca, NY: Palisade Corporation. Retrieved from https://www.palisade.com