An Analysis of Operating Profit Margin: A Valuable Tool for New Zealand Dairy Farmers

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Presentation Outline

1) Overview/Summary
2) The Context
3) Operating Profit Margin (OPM) Advantages
4) OPM Formula and Relationships
5) Our Approach
6) Econometrics
7) Results
8) Discussion

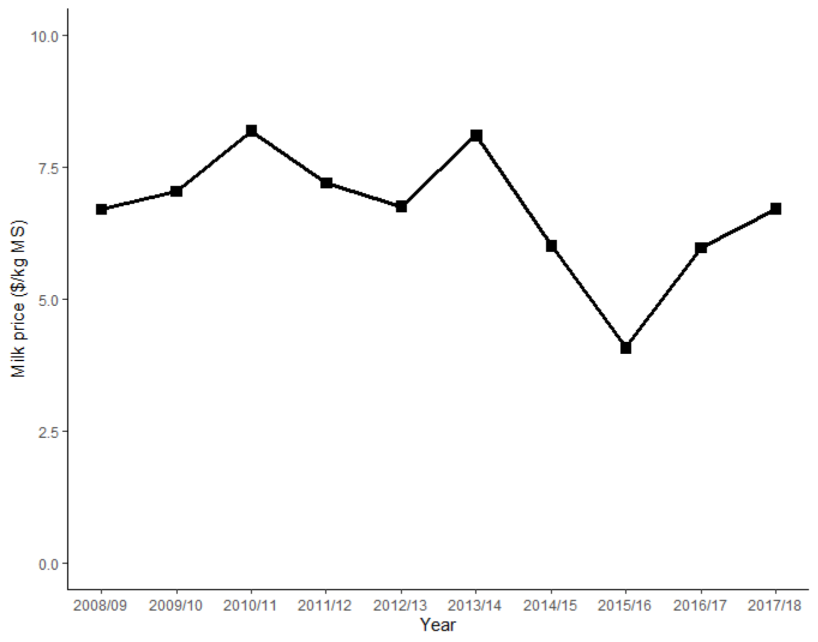
Overview

- New Zealand dairy farmers are operating in increasingly uncertain environments.
- Understanding farm profitability, efficiency and resilience is important now more than ever.
- Operating profit margin (OPM) is a useful metric for understanding profitability and resilience, and is also understandable to farmers.
- We study OPM over a ten-year period for farms in the Waikato region and look at how farms can improve their OPMs.
- We find that analysing OPM produces similar insights to more complex methods of analysing farm performance. Thus, demonstrating the value of analysing OPM (more cost and time-effective for farmers).

The Context

- The New Zealand dairy industry is worth over $17 billion per annum and is New Zealand’s largest export industry.

- Dairy farmers are facing several pressures and sources of volatility
  - Volatile milk price (price-taker model with no government subsidies)
  - Variable input prices
  - Climatic fluctuations
  - Stringent and increasing environmental regulation
  - High levels of debt



Milk price ($/kg MS) between 2008 and 2018

The Context: Environmental Regulation

A variety of policies and regulations demand environmental action by farmers. On top of that, customers are becoming more environmentally conscious.

- Farmers are developing action plans in accordance with the Sustainable Dairying Accord and The Action for Healthy Waterways.
- The new National Policy Statement (NPS) on Freshwater requires stricter monitoring and control of nutrient losses to waterways.
- The Government wants to reduce biogenic methane emissions by 10%, below 2017 levels, by 2030.
- There is discussion around incorporating methane emissions into the ETS.

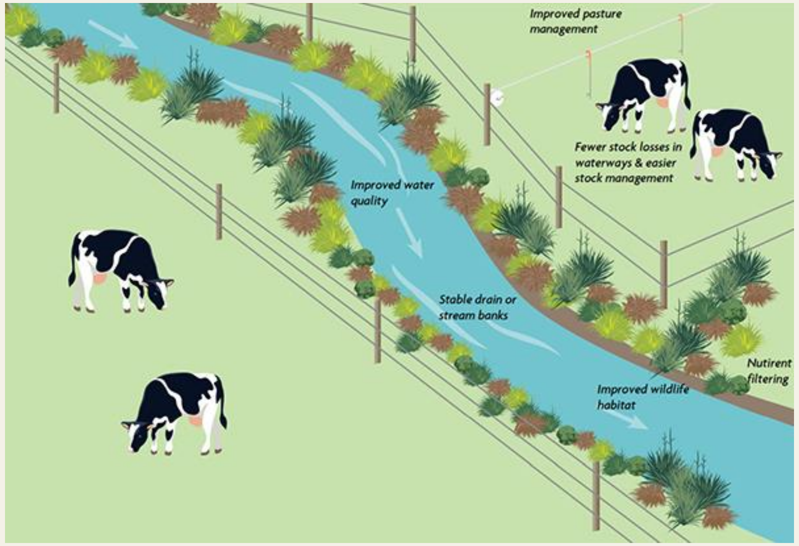


Diagram of farm environmental mitigation options

Operating Profit Margin (OPM)

- Operating profit margin (OPM) is given by:

$$\text{OPM} = \frac{OP}{OR} = \frac{OR - OC}{OR} = 1 - \frac{OC}{OR}$$

- If OC increase, *ceteris paribus*, OPM decreases (demonstrating a decline in relative cost efficiency) and vice versa

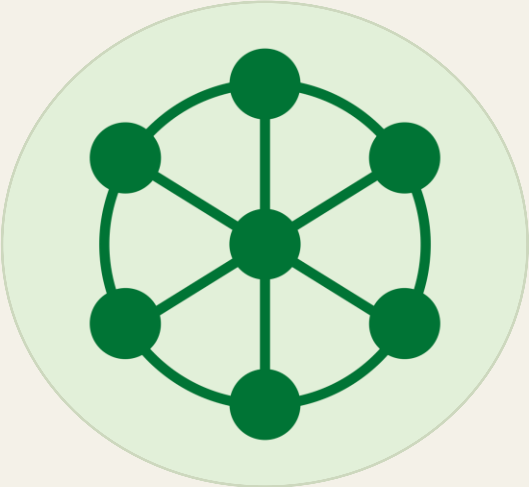
- OPM is part of the DuPont formulation (which is well-researched and globally applied)

Why OPM? Advantages

OPM is already computed by most farmers and is easily interpretable.[1]

OPM is strongly linked to profitability, resilience and cost efficiency.[2]

OPM is widely used internationally and has been show as an effective benchmarking tool.[3]



References:
[1] See Doole and Te Rito, 2019; & Grashuis, 2018.
[2] See Beca, 2020; & Grashuis, 2018; & Ma et al., 2018.
[3] See Doole and Te Rito, 2019; & Wolf et al., 2018.

OPM Literature Review

- OPM has strong positive correlations with farm performance in many areas, including profitability, RoA, RoE, cost efficiency and resilience.[4]
- OPM has been positively linked with operator/farmer education, but there is little research in this space (impact of farm-specific attributes on OPM). We do know that farm-specific variables influence profitability.[5]
- There are mixed findings around the correlations/relationships between OPM and intensification. Some authors find no correlation, some find that OPM decreases with system intensity and some find that RoA (inherently linked to OPM through the DuPont formulation) increases with intensity.[6]
- Financial performance (measured using metrics like OPM) are a way of managing risk. Hence, we expect OPM to be linked to risk exposure. We include the standard deviation of OPM as a proxy for business risk exposure (in line with OPM literature).[7]

References: [4] See Beca, 2020; Grashuis, 2018; Ma et al., 2018; Mishra et al., 2012
[5] See Brown et al., 2019; Mishra et al., 2012.
[6] Ho et al., 2013; Ma et al., 2018; Shadbolt, 2012.
[7] Bardhan et al., 2006; Yu et al., 2020

OPM: Spotlight on intensity

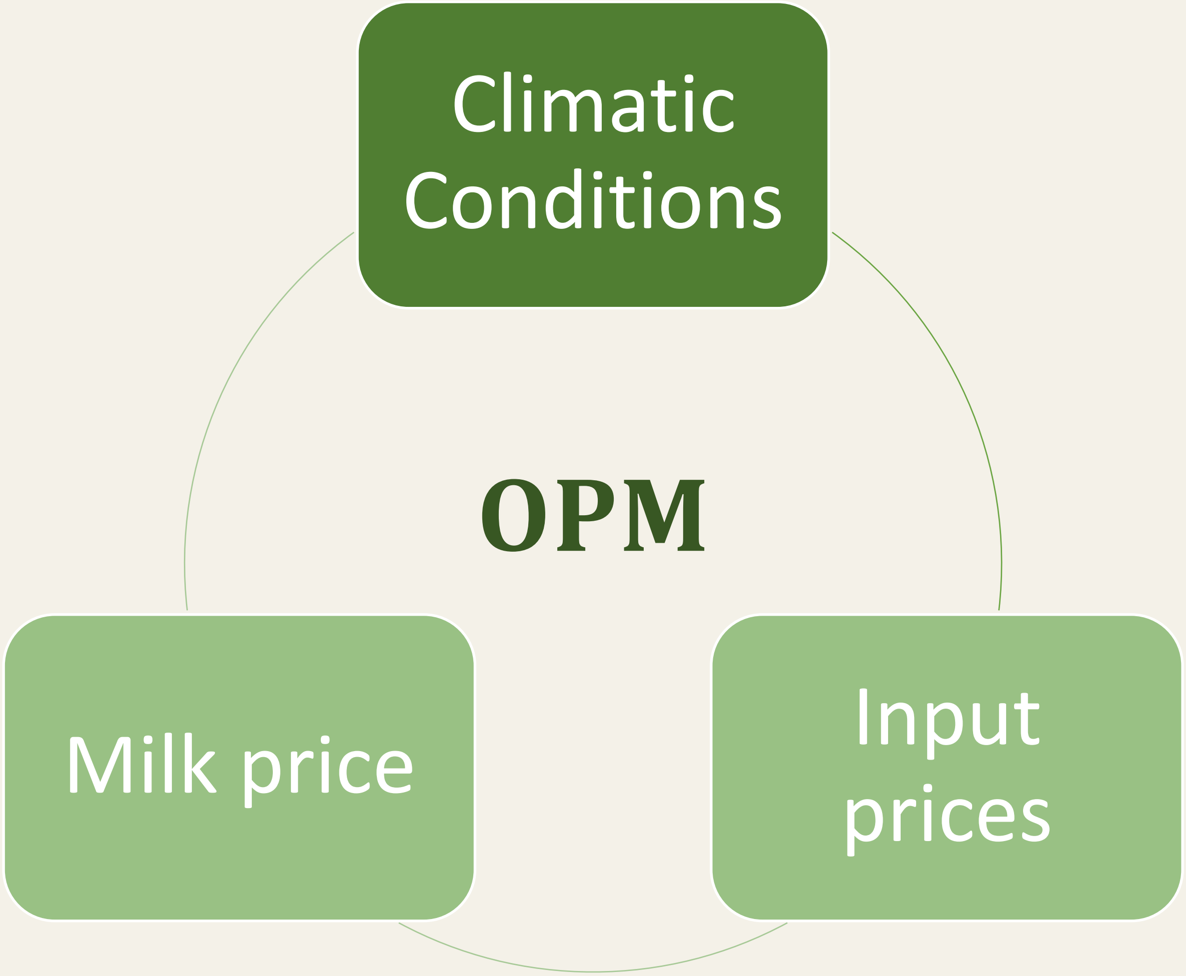
OPM = 1 – OC/OR.

With intensification, operating costs rise (more supplementary feed, fertiliser etc.) but so does operating revenue (greater milk production per hectare).

Whether OPM increases depends on the relative magnitudes of the increases in OC and OR.

If $\Delta OC > \Delta OR$, OPM will fall.
If $\Delta OR > \Delta OC$, OPM will increase.

These changes depend on the milk price (OR), input prices (OC) and climatic conditions (impacting both OR and OC – secondary feed market too). It is crucial to account for these factors when analysing OPM and intensity.



Our Approach: Data

- We source data from Doole et al. (2021) who leverage ten years of DairyBase sample data and LIC population data to simulate a comprehensive picture of the Waikato Dairy farming population.

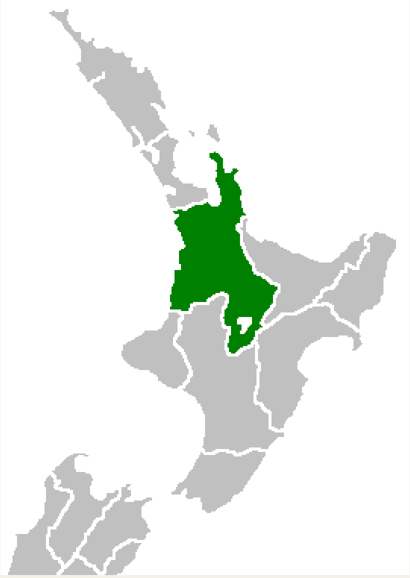
- This process preserves population distributions of key economic variables observed in the LIC dataset.

- The milk price included is the observed farmgate milk price for farmers from 2008 to 2018

- Biophysical variables are estimated using a dynamic, simulation-based framework of the biophysical interdependencies on the farm.

Data: The Waikato Region

- We restrict the population to farms from the Waikato region due to its large sample size (3745 farms) and diverse geographical nature.
- The Waikato region is in the upper central North Island, has an average annual rainfall of 1,250 mm and a diverse array of soil types and topography (WRC, 2019).
- The average herd size is 365 cows, and the average stocking rate is 2.9 cows/ha (DairyNZ, 2019).
- Previous studies have shown considerable regional heterogeneity across dairy farms in New Zealand, driven by climatic and topographical factors (Jiang and Sharb, 2014; Wales and Kolver, 2017).
- Studying one region allows us to control for some of that regional heterogeneity and avoid regional effects dominating our analysis.



NZ North Island with Waikato highlighted green

Econometric Approach

- We undertake a **three-step approach** to analyse and better understand the drivers of OPM on dairy farms. This approach is as follows:

Benchmark farms into quartiles based on their long run OPMs (10-year average).

Perform high-level Games-Howell hypothesis tests to investigate differences between quartiles.

Run fixed effects (individual and time) panel regression models for the entire population and each quartile (separately).

Econometric Approach: Insights

- In line with Wolf et al. (2021), benchmarking OPM is a useful way to understand relative farm performance and to differentiate between a diverse farming population.
- The Games-Howell hypothesis tests are simple pairwise comparisons between quartiles (accounting for heteroskedasticity).
- The fixed effects models allow us to control for milk and input price fluctuations (through time fixed effects) and unobserved time-invariant characteristics (i.e. education, gender, environmental endowment).
- Our fixed effects models investigate how farms can improve their OPM within their quartiles (quartile models) and how they may move between quartiles (model for the overall population).

$$\mathrm{OPM}_{it} = \alpha_t + \gamma_i + \boldsymbol{\beta}_1 \mathbf{X}_{it} + \mu_{it}$$

OPM_{it} represents the OPM for individual i, α_t is the intercept for each time period t, γ_i is the time-independent intercept for each individual farm i, μ_{it} is an error term for individual i at time t, $\boldsymbol{X_{it}}$ is a column vector of independent variables (regressors) and $\boldsymbol{\beta}_1$ is a row vector of coefficients.

Results

- “Better” farms had lower production yields, supplementary feed, nitrogen fertiliser, total emissions, business risk exposure and leverage.
- “Better” farms had higher homegrown feed consumed and cash operating surpluses.
- *Production yield is the ratio of MS/cow to potential MS/cow (based on biophysical modelling).

Table 2. Games-Howell test results comparing long-run farm variables between cost efficiency quartiles.

	Difference in variable between quartiles					
	Q4-Q1	Q4-Q2	Q4-Q3	Q3-Q1	Q3-Q2	Q2-Q1
Milk production (100s kg MS/ha)	-0.01	-0.22**	-0.15	0.14	-0.07	0.22*
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Milk per cow (kg MS/cow)	-3.48 (1.29)	-5.32 (1.31)**	-4.49 (1.30)*	1.01 (1.30)	-0.83 (1.32)	-1.84 (1.30)
Production yield	-0.05***	-0.04***	-0.03***	-0.02***	-0.01**	-0.01*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Stocking rate (cows/ha)	0.02	-0.02	-0.01	0.03	-0.02	0.04**
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Prop of feed that is supplement (%)	-8.19***	-6.42***	-4.11***	-4.08***	-2.31***	-1.77***
	(0.28)	(0.26)	(0.26)	(0.29)	(0.27)	(0.29)
Homegrown feed cons (t DM/ha)	0.76***	0.42***	0.27***	0.49***	0.14**	0.35***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Supplement cost ($/ha)	-432.85***	-344.00***	-216.17***	-216.68***	-127.84***	-88.85***
	(17.20)	(15.59)	(15.06)	(18.24)	(16.73)	(18.69)
Nitrogen fertiliser cost ($/ha)	-57.73***	-35.45***	-21.18***	-36.55***	-14.28***	-22.28***
	(2.22)	(2.03)	(1.92)	(2.27)	(2.09)	(2.36)
Total emissions (kg CO2-e/ha)	-510.90***	-493.03***	-248.20**	-262.71**	-244.82**	-17.88
	(63.04)	(62.67)	(63.27)	(65.39)	(65.03)	(64.81)
Leverage ratio	-0.35***	-0.27***	-0.10	-0.26***	-0.17*	-0.08
	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)
Cash operating surplus ($1000s/ha)	1.59***	0.92***	0.51***	1.09***	0.41***	0.67***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Std deviation of OPM	-0.07***	-0.03***	-0.02***	-0.05***	-0.01***	-0.04***
	(0.001)	(<0.0001)	(<0.0001)	(0.001)	(<0.0001)	(0.001)

- *Note: Robust standard errors in parentheses. *p<0.1; **p<0.05; ***p<0.01.; Q4 is the best and Q1 the worst*