Flexible sharemilking arrangements in New Zealand

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Abstract

Sharemilking is a widespread concept in New Zealand, similar to 'farming to halves' as practised since medieval times in England. Sharemilking is an entry point for new dairy producers in the New Zealand industry, and traditionally most sharemilking arrangements have been a 50/50 arrangement. These structures are relatively rigid in the share of milk income and apportionment of operating costs between the farm owner and sharemilker. Growing milk price volatility increases the business risks for sharemilkers. In a first step, we tested the hypothesis that flexible sharemilking arrangements will reduce the income variability of sharemilkers. The second step was to smooth the impact of changes in revenue shares and to reduce modality in income distributions. The results show that a flexible distribution of milk revenue reduces modality but shifts some of the revenue risk from the sharemilker to the farm owner, while still allowing both to generate a positive ROA and a positive net profit with high probability.

Keywords: *Sharemilking, income volatility, dairy, sustainable, risk, net profit, resilience, modelling*
JEL code: Q150; Q120; D810; C630

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1. Introduction

Farming of any type requires access to land and other farming assets, and access to land is determined by the land tenure arrangements of the farmer, who in some cases may be the landowner, however, a landowner need not be a farmer. There are numerous land tenure arrangements, as noted earlier simple land ownership is the most recognised (Reiss 1984), but other arrangements, such as renting or leasing, contracting, or sharefarming are also practised in many countries around the world, or in different regions in those countries. Land tenure arrangements also affect the types of risks to which those involved in the various tenure arrangements are exposed. Efficiency of production or the ability to maximise profit can also be affected by land tenure agreements (Heady 1952).

Sharefarming is not a new form of land tenure, indeed Griffiths and Overton (2009) provide numerous examples and discussions of sharefarming arrangements in the United Kingdom dating back as far as the 13th century. Griffiths and Overton (2009), also discuss the factors that have affected sharefarming over the same period, these include prices of products, other tenure arrangements which may have lower risks for land owners, such as renting whereby the landowner is guaranteed a certain income no matter what prices of product maybe, and the inability of landowners to secure sharefarmers or the inability of sharefarmers to generate sufficient profit to make sharefarming a viable alternative to leasing or rental. Newbery and Stiglitz (1979) make a similar set of arguments and suggest that the choice of share cropping or share tenancy cannot be examined separately from the markets for labour and land rental and that these markets are inextricably linked to the success or failure of sharecropping. These authors also add in a discussion of the impact transactions costs may have on the choice of sharecropping or land rental for farmers and landowners (Newbery and Stiglitz 1979).

In most of the examples presented in Griffiths and Overton (2009) most sharefarming arrangements were crop share, where the landowner and the sharecropper contribute "equal" shares of inputs and receive a similar share of output, however examples of sharefarming agreements for sheep, beef cattle, and dairy cows, where wool, offspring (lambs or calves), and

milk revenue were shared by the parties to the agreement, were also presented. Various authors (Heady 1952, Ottoson 1955) have presented arguments as to why sharefarming is an inefficient form of land tenure due to perceived lack of incentives for sharefarmers to generate maximum profit as they do not receive all income from production, or the perception that sharefarmers may retain the "best" quality production to the expense of the landowner. In contrast, Allen and Lueck (1992) suggest that landowners do not monitor share croppers to ensure "equal" share of the crop produced, and that the shares are not equal, but equitable. Furthermore, to follow on from Newbery and Stiglitz (1979), Allen and Lueck (1992) argue that contract choice, sharecrop or land rental, is due to transactions costs of both parties in the contract. Others have also argued that sharefarming is essential to maintain flexibility and continuity of land use (Reiss, 1984).

One further point that has received some interest in the literature is the asymmetry of risks, risk sharing, and risk preferences of parties to the contract, landowner and tenant or sharecropper. Allen and Lueck (1992) ignore risk sharing and assume both parties are risk neutral, however subsequent authors have indicated that risk sharing and the incentives provided to parties of the contract affect how the returns in the contract are shared and provide incentives for the parties to use a specific form of contract (Ackerberg and Botticini 2002, Serfes 2005).

The criticisms of sharefarming are somewhat valid, but are specific to sharecropping, where the landowner and sharecropper received equal shares of production. In contrast, in livestock-share leases or sharemilking contracts, income or revenue is shared rather than physical product, thus removing the incentive of the sharefarmer to keep the best product and providing more incentive to produce at the profit maximising level of production (Ottoson 1955. Edwards 2005, Shadbolt and Martin 2005).

Sharemilking in New Zealand

The dairy industry in New Zealand is a significant contributor to the national economy generating $NZ7.8 billion (£4.1 billion) to GDP or 3.5% of total GDP (Ballingall and Pambudi 2107) and is expected to generate $NZ17.2 billion (£9.0 billion) in export earnings in 2019 (MPI 2018). There were 11,748 dairy herds in New Zealand in the production year 2106/17. Of those 8,508 were owner operated businesses, and 3,203 were operated by herd-owning sharemilkers (HOSM), with the remaining 37 unclassified, but as can be seen HOSM make up a significant proportion of dairy businesses in the country. However, the number of HOSM in the population declined by over 900 herds over the period 2009/10 to 2016/17, while the

number of owner operated herds increased by just under 1,000 (DairyNZ 2011, 2012, 2013, 2014, 2015, 2016, 2017a, 2018b).

Sharemilking is seen as a pathway to farm ownership in New Zealand, where sharemilkers begin as contract milkers, progress to lower-order or variable order sharemilkers (VOSM), then to HOSM. Contract milkers, as the name implies milk cows under contract and are only responsible for milking cows, dairy shed maintenance and the costs associated with the milking shed, such as cleaning products, rubberware and electricity. The landowner/farmer with a contract milker still maintains full ownership of all assets; cows, land and machinery, and retains all decision making, and pays all costs except for those related to milking and the milking shed (Shadbolt and Martin 2005).

Lower-order or VOSM, do not own any cows, but may own some machinery, and are responsible for milking cows, either directly or by hiring staff, and for herd and pasture management, as well as the same share of milking shed expenses as the contract milker in return for a percentage of milk revenue (between 21-29%) depending on duties, experience and contributions to costs (Shadbolt and Martin 2005). In the case of a VOSM the landowner still retains ownership of cows, land and most machinery, has a significant role in decision-making, and receives the balance of the milk income and all livestock income (Shadbolt and Martin 2005).

As the name implies herd-owning sharemilkers own the milking herd and replacement herd, most machinery (tractors, forage wagons, seeding equipment, and motorbikes), and pay half the costs of feed and forages, nitrogen fertiliser, all herd health and reproduction costs, and are partially responsible for repairs and maintenance costs, as well as capital fertiliser (non-nitrogenous fertiliser) spreading. The landowner with a HOSM in place, provides the land and any land-based capital such as irrigation equipment, the milking facilities, and housing for the HOSM. In this case the HOSM retains all income from livestock sales, and 50 per cent of milk income and the landowner receives the other 50 per cent of milk income (Shadbolt and Martin 2005).

One of the major risks that dairy farmers face in the current operating environment is that of price risk, and for sharemilkers the impact of milk price variability can be significant, particularly in periods of low milk price as their income is tied to milk price. Furthermore, for the HOSM the impact is exacerbated as their major asset, the milking herd, is reduced in value as cow prices decline in parallel with milk price (Schröer-Merker and Tozer 2019). However,

land prices are more resilient to short term variability, hence landowners are somewhat more protected in terms of asset value and their ability to borrow using land as a collateral, to finance short term cash requirements than sharemilkers.

Unlike dairy producers in other countries such as the USA, New Zealand dairy farmers receive a single price per year for the milksolids (MS) supplied to the dairy company throughout the production year. Milksolids prices may fluctuate throughout the year based on market conditions, but the final MS price paid to producers is adjusted to take into account these fluctuations. Mean real MS price over the period 1998/99 to 2016/17 was $6.22 per kg, with a standard deviation of $1.33 per kg. However, as can be seen in Figure 1, there can be large between year variations in price, with a range of annual change in price of -$3.90 to +$3.50 (DairyNZ 2017c).

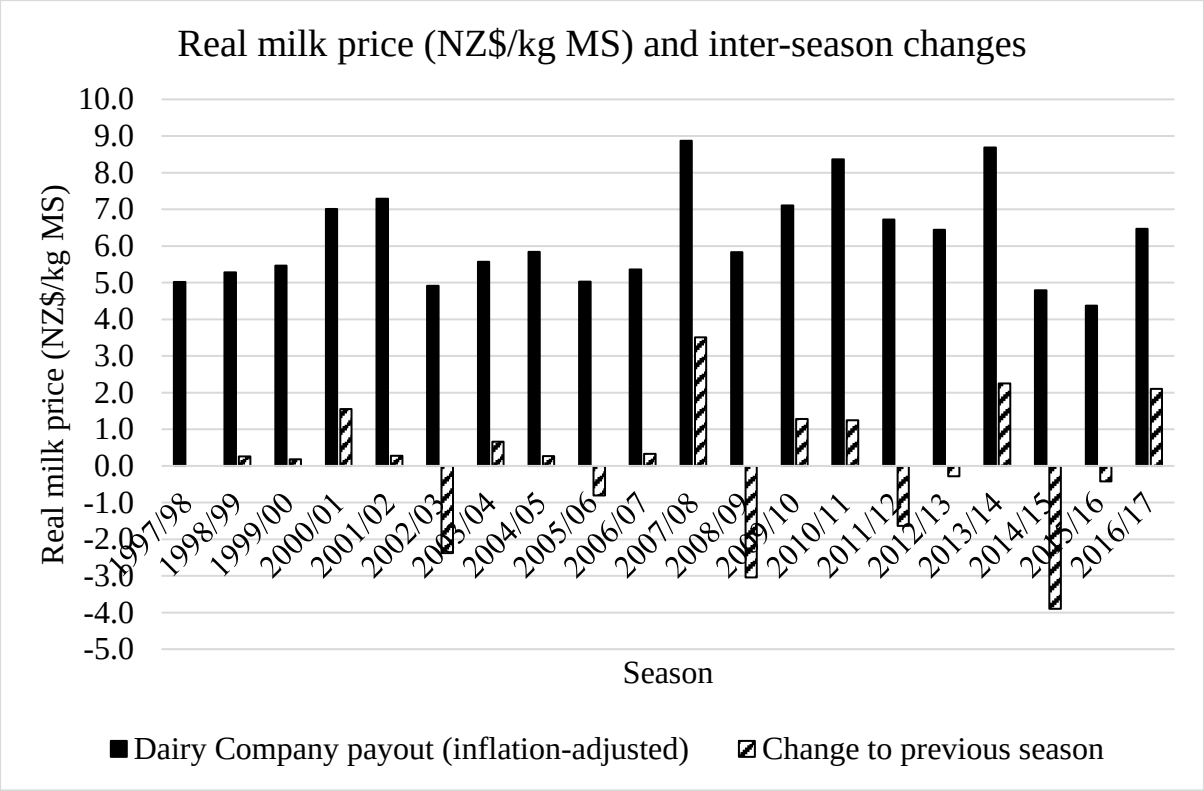

Figure 1. Real milk price in NZ$ per kg MS and inter-season changes (Data from DairyNZ 2017c)

Previous research has shown that adjusting the share of milk income from 50:50 to each party to 60:40 or 40:60, when the price for milk solids fell below $NZ4.59 or rose above $NZ8.93, respectively, improved the financial position of HOSM, measured in terms of cash operating surplus, net profit, and return on assets (ROA) of HOSM (Schröer-Merker and Tozer 2019). The price bounds were set to reflect milk prices within them with 90% probability (Schröer-Merker and Tozer 2019). However, the "hard" ratio of 60:40 is inequitable to the landowner

in terms of impact on cash surplus when milk prices are low. The current research builds on this previous research to add more flexibility into the share of milk income to sharemilker and landowner, and examines the impact of changing the shares allocated to both parties on financial returns: cash operating surplus, net profit, and ROA. The current research will also extend to include VOSM and how changing the allocation of income or moving the VOSM to a more stable form of income, such as contract milking, can improve the economic wellbeing of this group of farm contractors, and endeavours to answer whether VOSM is a viable pathway for entry in dairy farm ownership.

2. Method and Materials

A cash operating budget was developed in EXCEL (Microsoft 2019) for each business entity studied, a HOSM and the associated landowner, and a VOSM and the landowner/farm manager. A steady state balance sheet was developed to allow estimation of return on assets (ROA) for each entity. The base model for comparison was a 292 ha farm, (225 ha milking area) with a 550-cow milking herd of a feeding system 2 or 3 pasture-based system in New Zealand (DairyNZ 2017b), the case study farm is larger in farm area and herd size than the average in New Zealand of 148 ha milking area and 415 cows (DairyNZ 2017b) To measure the effects of milk price variability the EXCEL add-in @RISK (Palisade 2019) was used to construct probability distributions around variables that have a significant impact on the cash operating surplus or net farm income of each business type. The major variable of interest in the dairy industry is the price of milk, or in the case on New Zealand producers are paid on a per kilogram of MS basis, where MS are the sum of fat, protein, lactose and minerals after water has been removed from the raw milk.

It was assumed for the HOSM and the associated landowner that 20 per cent of capital was borrowed, similarly for the VOSM, although the assets for the VOSM are relatively minimal with a motorbike and a vehicle constituting the major assets for this entity. Also, the HOSM was assumed to own all necessary capital; machinery, vehicles and cows, to operate the farm, and the only asset contribution from the landowner was for land, buildings and improvements, such as roads and fences; no irrigation infrastructure was included. In the case of the HOSM it is also assumed the HOSM undertakes the role of farm manager and takes a salary for that role, the landowner does not supply any labour input into the operation of the business. In contrast, in the scenario for the VOSM, the VOSM provides a vehicle and motorbikes, as noted

earlier, but the landowner provides all other machinery, cows, land and buildings, and does provide some labour input, including management.

Four stochastic inputs were incorporated into the model; MS price ($NZ/kgMS), cow price ($NZ/cow), supplementary feed expenses per cow ($NZ/cow), and total urea expense for the farm ($NZ). As noted earlier, MS are the major revenue stream for the dairy system, hence MS price will drive gross revenue and volatility in milk price can affect the economic status of each entity. Cow price is included as the cow herd is the principal asset of the HOSM, and changes in cow price affect the value of the capital invested in the farm by the HOSM. Other than labour and pasture costs, supplementary feed costs are the next highest expense for a dairy farm (DairyNZ 2011, 2012, 2013, 2014, 2015, 2016, 2017a, 2018b), and variability in feed costs can have an effect on ROA and operating profit of the dairy farm. Nitrogen, in the form of urea, is the principal input into the pasture-based systems in New Zealand and is treated similar to a feed cost as rainfall and nitrogen are the principal drivers of pasture production, and therefore feed availability, and variability in urea price can affect pasture costs and total economic returns in the dairy system.

As shown earlier the MS price has been highly variable over the past 20 years, and based on Akaike Information Criteria and other fit statistics a lognormal distribution was chosen as the most appropriate for MS price. Data on dairy cow prices is difficult to attain, as most cow prices are for animals sold as beef, however one data set has the average market price for cows as a capital item. This data set is used to value cows each year as assets to be reported in income tax calculations and is based on average market value across New Zealand (IRD 2018). The issue with the data set is that it contains a relatively small number of observations (7), this data showed that over the period 2012 to 2018, which represents milking production seasons 2011/2012 through to 2017/2018, the average Friesian milking cow price was $NZ1,750 with a standard deviation of $300. A correlation analysis of milksolids price and milking cow price showed that the correlation between the two series was 69% or $\rho = 0.69$, indicating a reasonably high correlation.

As New Zealand dairy systems are pasture based and pasture forms the major feed intake, a proxy for pasture costs is the price of nitrogen fertiliser in the form of urea, as urea is used to maintain pasture growth throughout the production year. Total urea expenses were sourced from DairyBase (DairyNZ 2018a) and adjusted for inflation using the Producer Price Index for farm inputs (Stats NZ, 2018). Average pasture expense was assumed to have a triangular

distribution with a most likely value of $NZ53,000, and low and high values of $46,000 and $84,858, respectively.

Even though pasture provides the major source of feed in these systems, supplementary feed is also purchased by most dairy farmers to supplement pasture in periods of low growth or high energy demand by the milking herd. In the current study the price of palm kernel expeller meal was used as the proxy for supplementary feed costs, mean price over the period 2009/10 to 2016/17 was $NZ209 per tonne, and standard deviation of $NZ31 per tonne (DairyNZ 2018a).

Other costs were derived from interviews with a case study farmer. Animal health costs (including reproduction costs) were $NZ66,000, other feed and fertiliser related costs of $150,000, and working and fixed costs, such as electricity, repairs and maintenance to plant, buildings and machinery, and administration of $NZ170,000. These costs were assumed to be relatively static and non-stochastic.

In the case of the HOSM the share of revenue based on milk price is: 60% to the HOSM when milk price is below $4.50/kg MS, 55% when price is between $4.50 and $5.00/kg MS, 40% when price is greater than $10/kg MS, for prices in between $5.00 and $10.00/kg MS the revenue is shared equally between the HOSM and the farm owner. The ranges were selected to keep mean income approximately equal in the base case and the flexible revenue sharing arrangement. Average median earning in New Zealand in 2018 was close to $52,000, according to StatsNZ (2019). Preliminary analysis showed that for the VOSM to generate sufficient revenue to earn a salary above $40,000, MS price had to be greater than $5.50/kg MS. Thus two limits were established: a milk price floor at $5.50/kg MS; if the milk price was below this value the VOSM received a 21% share of $5.50/kg MS multiplied by total milk production and the landowner's revenue was the difference between the VOSM income and total milk income; and a milk price ceiling at $10/kg MS where the VOSM received 21% of $10/kg MS multiplied by total milk production while the landowner received the difference between total milk income and VOSM share. For MS prices between $5.50 and $10 the share was 21% to the VOSM and 79% to the landowner as per the standard sharemilking agreement (Parliamentary Counsel Office 2011). The income level of $40,000 is the approximate annual salary of a minimum wage earner in New Zealand. The simulation model ran for 10,000 iterations to ensure consistency in results.

3. Results

Herd owning sharemilking agreement

The base model shows that average net profits are higher for the farm owner, while for the HOSM it is skewed with a relatively high probability of being zero or negative. The base system, under a standard sharemilking agreement, showed that the HOSM is facing a higher probability of low returns compared to the farm owner.

In the initial approach for the flexible model (Schröer-Merker and Tozer 2019), for the HOSM, the probability of low financial results is reduced, while the probability of very higher returns is also reduced, indicating a narrower range, due to the mean-preserving spread. In contrast, farm owners have a higher probability of lower results under the flexible arrangement, while also increasing the probability of high results, indicating an increase in the range of returns to farm owners.

The results of this second model showed that bimodality was reduced without significantly reducing the profit of the HOSM (Figure 2) or the landowner (Figure 3) in comparison to the results of the initial flexible pricing model (Schröer-Merker and Tozer 2019).

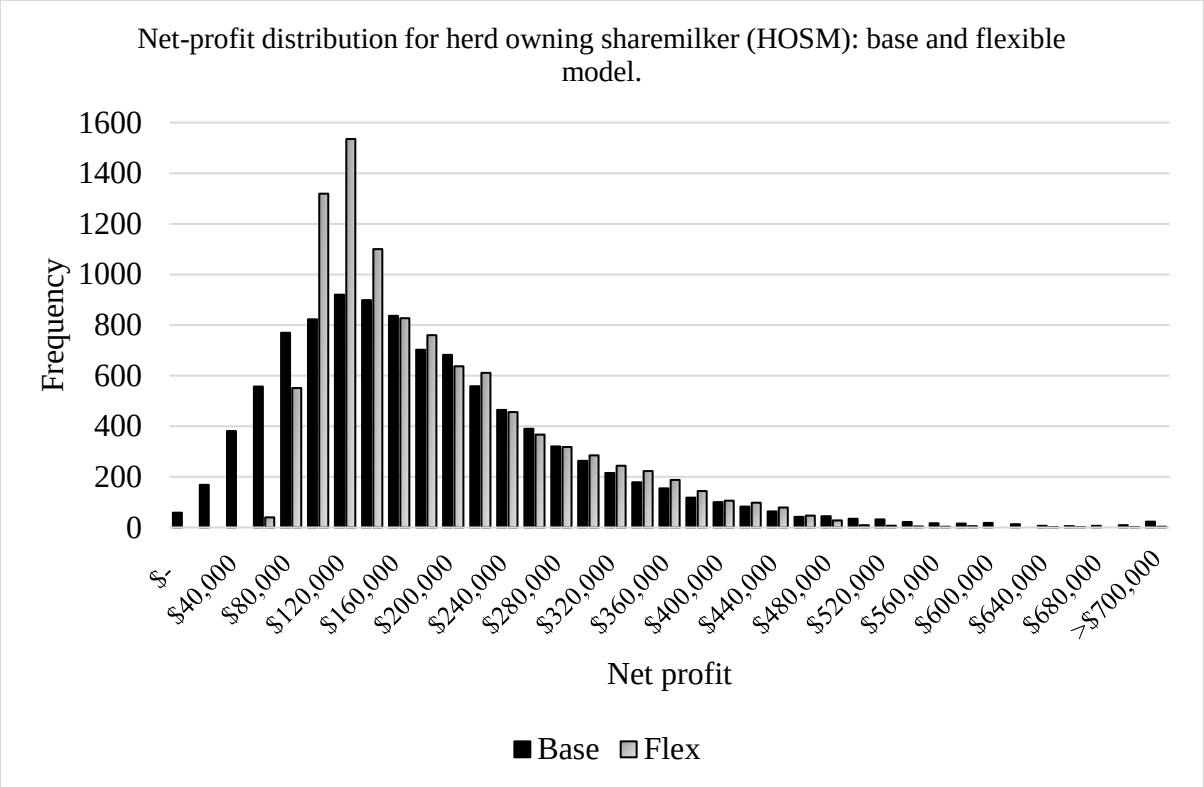

Figure 2: Net-profit distribution for herd owning sharemilker (HOSM): base and flexible model.

The frequency of net profit being less than $80,000 or greater than $480,000 decreased for the HOSM in the flexible model, while the frequency of net profit being between $100,000 and $140,000 increased (Figure 2). As can be seen in **Error! Reference source not found.**, the mean income of the HOSM increased in the flexible model, while standard deviation was reduced by curtailing the probability of very high or very low results.

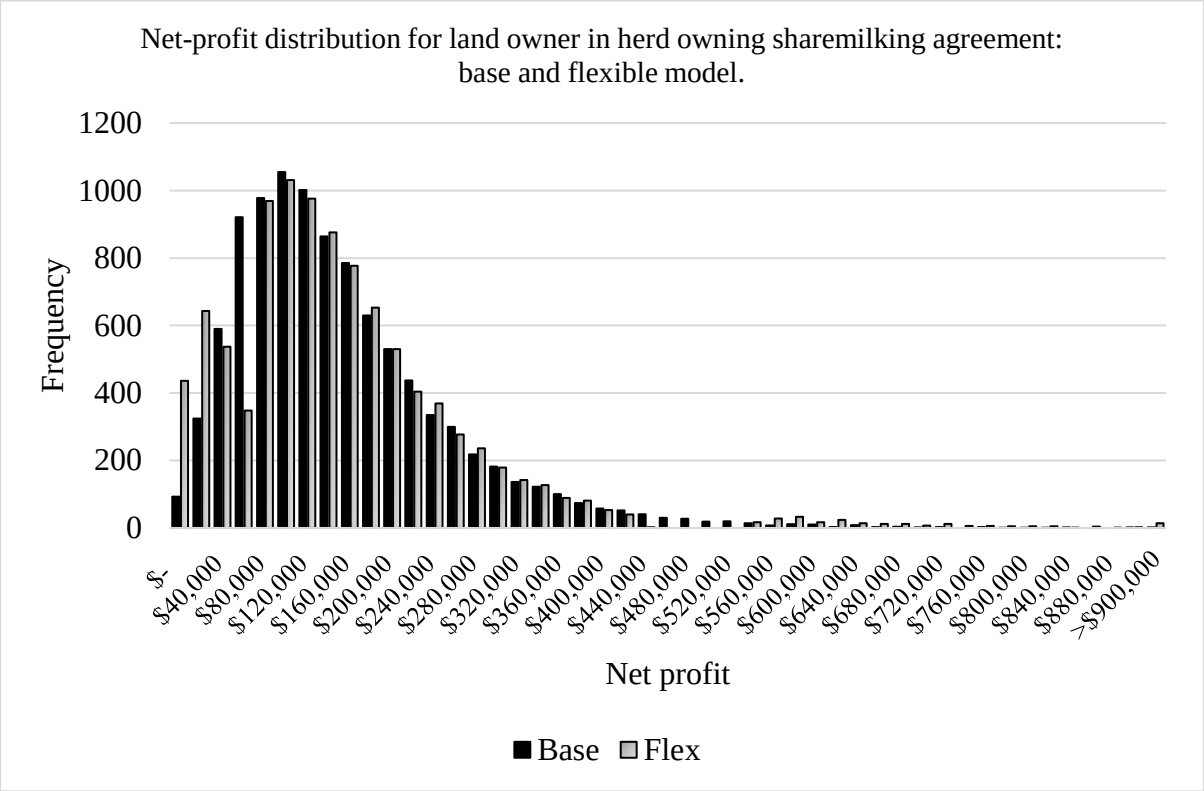

Figure 3: Net-profit distribution for farm owner in herd owning sharemilking agreement: base and flexible model.

In contrast, the landowner in the herd owning sharemilking agreement has an increased chance of net profit being less than $20,000 or greater than $540,000 (Figure 3).

Table 1: Detailed results for net profit, for farm owner and herd-owning sharemilker (HOSM)

Parameter	Median (NZ$)	Mean (NZ$)	Standard deviation (NZ$)	5% probability of being ≤ NZ$	5% probability of being ≥ NZ$
HOSM – base	150,470	172,941	113,958	35,695	385,923
HOSM – flexible	150,571	177,669	91,938	78,020	365,168
Owner – base	120,724	143,497	103,125	23,517	339,779
Owner – flexible	121,418	142,598	120,925	3,258	336,758

The mean income for the farm owner was slightly lower in the flexible model, while standard deviation increased (**Error! Reference source not found.**). In both cases, the HOSM and farm owner, the median remained stable (HOSM +0.06%, owner +0.6%).

Variable order sharemilking agreement

In the case of a variable order sharemilking agreement, the VOSM has a comparatively lower range of potential net profit (Figure 4, Table 2) due to the distribution of milk income with the price-limits, while the range is higher for the landowner (Figure 5, Table 2).

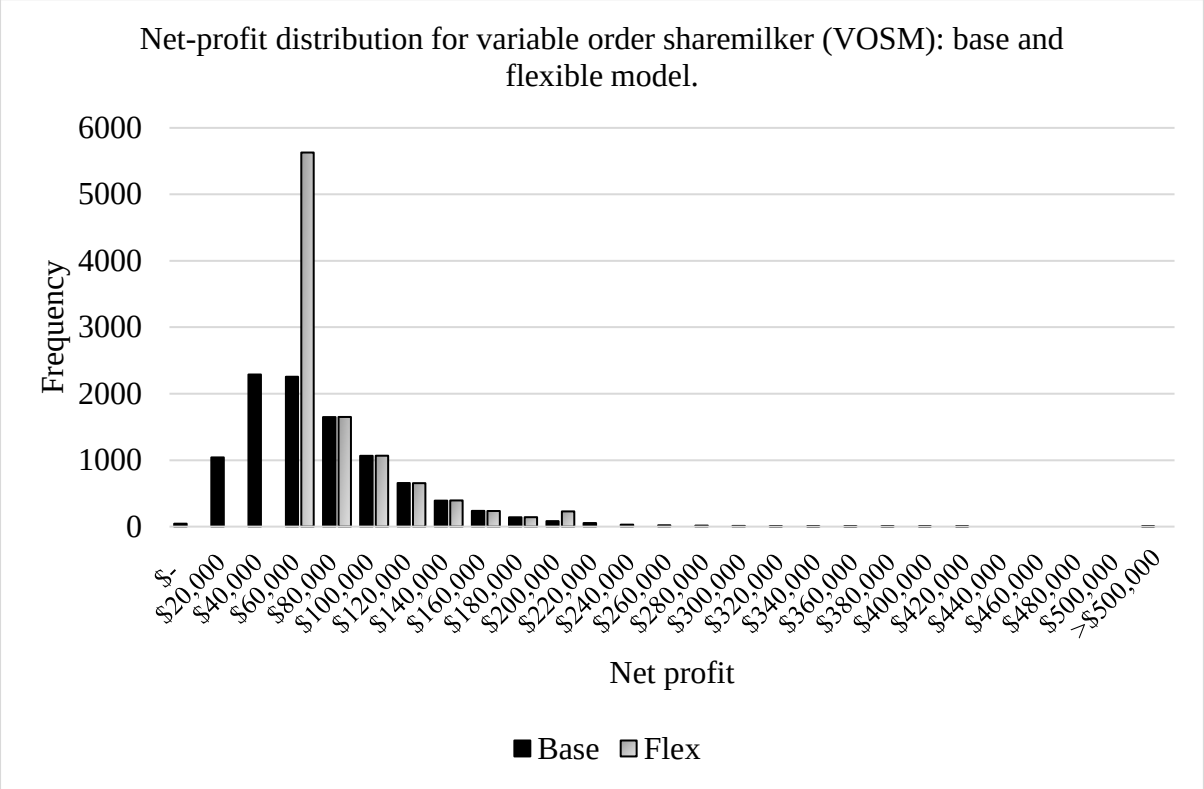

Figure 4: Net-profit distribution for variable order sharemilker (VOSM): base and flexible model, with established $5.50/kgMS price floor and $10/kgMS price ceiling.

In the flexible model, probability of the VOSM having a net profit ≤ $40,000 is decreased to zero, while the probability of net profit of >$40,000 up to $60,000 increased by 149% compared to the base model (Figure 4). The flexible model increases the mean value for the VOSM, and reduces income variation (standard deviation), while keeping the median virtually stable (Table 2).

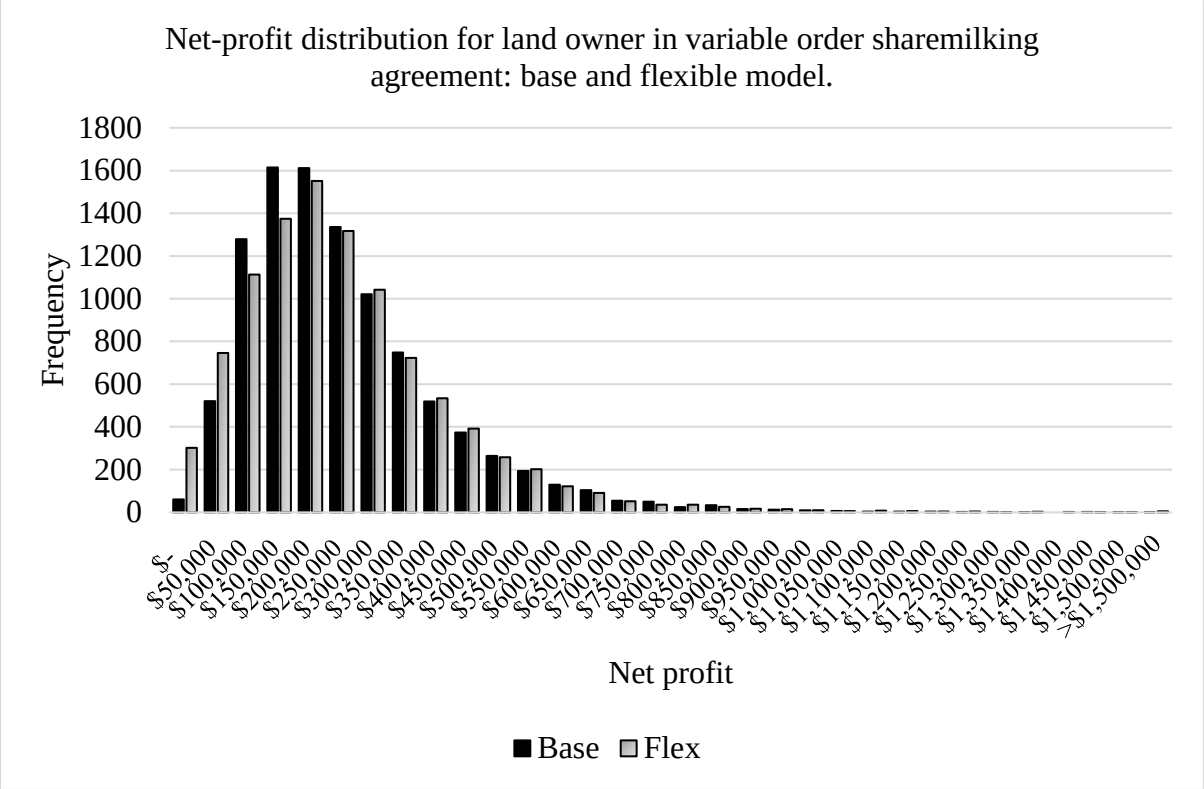

Figure 5: Net-profit distribution for farm owner in variable order sharemilking agreement: base and flexible model, with established $5.50/kgMS price floor and $10/kgMS price ceiling.

Under the flexible model farm owners face a higher probability of net profit being less than $50,000, most of which is shifted from a lower probability of a net profits between >$50,000 to $150,000 (Figure 5). As for VOSM, the median for farm owners is virtually stable, while for this party the mean is decreased and the standard deviation increased, reflecting a shift of risk from the VOSM to the farm owner, at the same time leaving the 'middle value' stable.

Table 2: Detailed results for net profit, for farm owner and variable order sharemilker (VOSM) with established $5.50/kgMS price floor and $10/kgMS price ceiling

Parameter	Median (NZ$)	Mean (NZ$)	Standard deviation (NZ$)	5% probability of being ≤ NZ$	5% probability of being ≥ NZ$
VOSM – base	53,936	63,718	44,386	12,667	147,800
VOSM – flexible	53,930	68,229	35,217	40,931	147,682
Owner – base	197,112	232,253	161,196	45,117	539,788
Owner – flexible	197,248	227,703	172,123	18,103	535,012

4. Discussion and Conclusions

The flexible model successfully showed a mitigation of downside risk in case of low milk prices for the HOSM and VOSM, while foregoing upside risk in high milk price seasons as well. Especially in the case of the VOSM, the flexible model brings net profit results closer to median earnings in New Zealand. This is particularly significant since 'own' or family labour is not included in the net profit calculations. Thus, a positive net profit is not only necessary to be able to reinvest into the business, but also to cover personal drawings and ideally provide themselves with adequate remuneration for their time input into the farming business.

While the farm owner has additional downside risk in the flexible model in low milk price seasons compared to the base model, the likelihood for high returns is also increased in case of high milk prices, due to reverse distribution of milk income. Farm owners are expected to be able to better cope with additional downside risk as they have the land assets to borrow against, if needed.

The farmer's and sharemilker's attitude to risk, and credit availability will likely be main factors in the choice of such a model, as well as its specifications, especially the milk income distribution and the cut-off milk prices at which the flexible model is activated.

The past years showed a downward trend of sharemilking arrangements, while overall herd numbers in New Zealand remained stable (DairyNZ, 2017c). This decline is believed to stem, at least in part, from the associated risk for sharemilkers in low milk price seasons (Pepper, 2013), as reflected in the base model, which is negatively impacted by higher milk price volatility in recent years. Overall, it is believed that the introduction of such a flexible model, with the aim of mitigating extreme downside risk away from the sharemilkers, can help to make HOSM and VOSM attractive options for entrants to the dairy industry in New Zealand once again.

This approach allows decision rules to be built into the models based on revenue sharing to reduce income variability. While the study showed the general feasibility of flexible sharemilking agreements, we recommend building on the existing research by analyzing a range of 50/50 sharemilking cases as well as monthly cash-flow budgets.

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