Returns from training in the dairy farming industry

Part A: The relationship between formal qualifications and employee income

September 2016

Introduction

Context

DairyNZ, the Primary ITO, and many of the organisations that they both work with, share a goal of encouraging dairy farmers to undertake formal training. To achieve this, it is important to demonstrate the benefits of training to both employers and employees.

This report forms part of a wider piece of work led by DairyNZ and Primary ITO to examine the returns from training both qualitatively and quantitatively.

Overview

The analyses presented here explore the relationship between formal qualifications and the individual income of segments of employees in the dairy farming sector. Intuitively better qualified staff should be paid more, all other factors being equal. Data obtained using Statistics New Zealand's Integrated Data Infrastructure (IDI) are used to test this hypothesis. This work is a preliminary analysis and further work is recommended to explore a range of issues arising from this work.

Structure

The first section of this report explores the influence of qualifications, experience and gender as determinants of monthly income for dairy farm employees. The second part duplicates these analyses for another industry - engineering consultancy and design – to serve as a benchmark. The final section presents a short statistical analysis to characterise the relative importance of qualifications, experience and gender in setting income.

Disclaimer

The results in this report are not official statistics, they have been created for research purposes from the Integrated Data Infrastructure (IDI), managed by Statistics New Zealand.

The opinions, findings, recommendations, and conclusions expressed in this report are those of the author(s), not Statistics NZ.

Access to the anonymised data used in this study was provided by Statistics NZ in accordance with security and confidentiality provisions of the Statistics Act 1975. Only people authorised by the Statistics Act 1975 are allowed to see data about a particular person, household, business, or organisation, and the results in this report have been confidentialised to protect these groups from identification.

Careful consideration has been given to the privacy, security, and confidentiality issues associated with using administrative and survey data in the IDI. Further detail can be found in the Privacy impact assessment for the Integrated Data Infrastructure available from www.stats.govt.nz.

The results are based in part on tax data supplied by Inland Revenue to Statistics NZ under the Tax Administration Act 1994. This tax data must be used only for statistical purposes, and no individual information may be published or disclosed in any other form, or provided to Inland Revenue for administrative or regulatory purposes.

Any person who has had access to the unit record data has certified that they have been shown, have read, and have understood section 81 of the Tax Administration Act 1994, which relates to secrecy. Any discussion of data limitations or weaknesses is in the context of using the IDI for statistical purposes, and is not related to the data's ability to support Inland Revenue's core operational requirements.

Key findings and discussion

Formal qualifications increase dairy farm employee earnings

There is a positive correlation between the qualification levels and the incomes of dairy farm employees. The difference in average income of staff with qualifications at level 3 or above is approximately 10% higher than that for employees with level 1-2 qualifications or without qualifications at all.

High self-employment may limit our ability to analyse the impact of qualifications in employee data

While there is a positive correlation between qualifications and income for dairy farm employees this is less than that for other industries that we have benchmarked – notably carpentry and forestry. It is likely that this reflects typical career pathways in dairy farming which see skilled employees quickly stepping into self-employment (and hence out of the data set we have analysed in this work). The results for beef & sheep farming, which features even greater levels of self-employment, support this hypothesis with a lower correlation between income and qualifications than for dairy farming.

Experience is the most important determinant of income

Compared to qualifications, experience is approximately four times more important. Gender also plays a large role in setting income although this may be due, in part, to differences in hours worked (which is difficult to correct for using the data available).

Further work would improve our understanding of the impact of qualifications

This work is a preliminary analysis and more can be done to refine it. For example, further analysis could explore the impact of qualifications on income once workers become self-employed, examine longer income earning periods, compare the impact of industry-specific training vs other qualifications at the same level, develop more sophisticated regression models for the determinants of income, and investigate business returns along with personal income.

Summary of methodology

Data available in Statistics New Zealand's IDI were analysed by working through the steps below:

1. Individuals working as dairy farm employ**ees** were identified from the 2013 census. Employ**er** income was not considered in this analysis as this is tied closely to business income – a potential subject of future analyses.
2. Individuals' age, sex, highest qualification, and hours worked were queried – all from census data.
3. Individuals who stated that they worked for more than 30 hours per week (here used as the threshold for 'full time' work) were retained and individuals working less than 30 hours per week were excluded from the analysis.
4. Individuals' income and tax history were queried from Inland Revenue database.
5. From their tax histories, workers' experience (defined as the total years worked for dairy farming enterprises – 'tenure') and monthly income as of 31st of March 2013 were derived.
6. The resulting data table, containing age, sex, highest qualification, tenure, and income, was then aggregated using different variables (e.g., by highest qualification by tenure bracket) and summary statistics obtained.
7. 5%, 25%, 50%, 75% & 95% quantiles were derived to create the box and whisker plots shown on the following slides.

Data limitations

Data availability imposes a number of limitation on this analysis. The points below should be considered while interpreting the results:

1. Data on hours worked are crude and not directly related to income. Census respondents state the hours that they *typically* work but there are no data available to indicate how many hours were *actually* worked in the month analysed (March 2013). Consequently a person that worked 60 hours for $20 per hour will be treated the same as a person who worked 30 hours for $40 per hour.
2. We have analysed only a single month in order to align with the month of the 2013 census. Presumably some workers will have earned atypically high or low income in that month. For example, a worker could have been away on holiday for part of the month.
3. Self-reported census data may not be accurate. For example, some respondents record occupations and industries that don't seem compatible.

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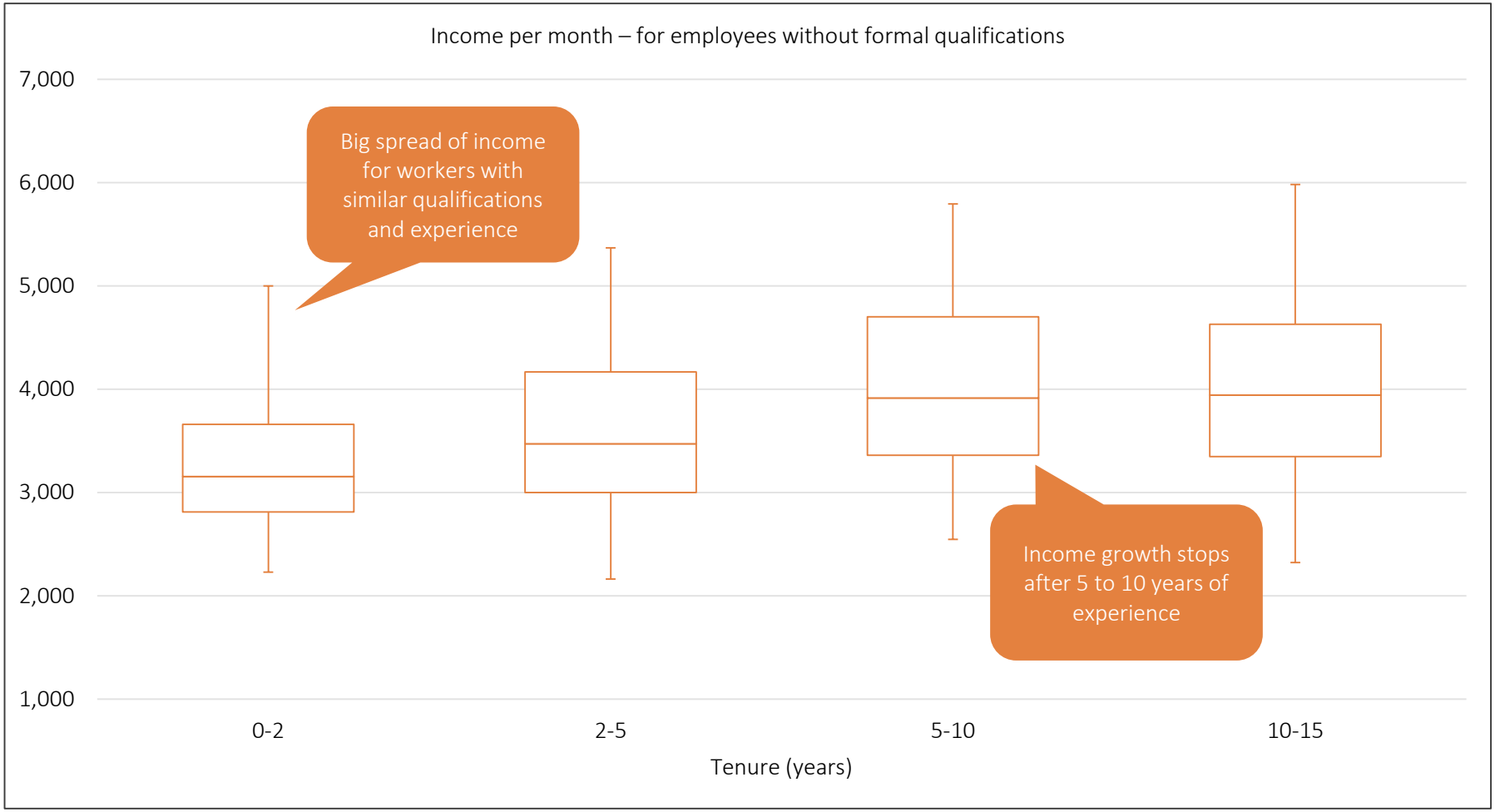
Within any given group of workers with similar attributes there is a wide range of income variation. This means that the influence of qualifications needs to be analysed within a 'noisy' background. However, the average impact of experience is clear even within this noise.

The impact of experience and 'noise'



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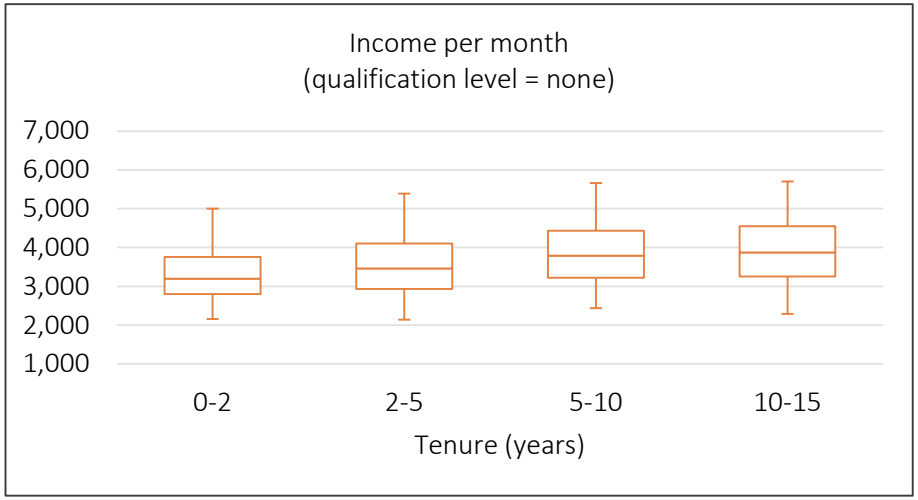
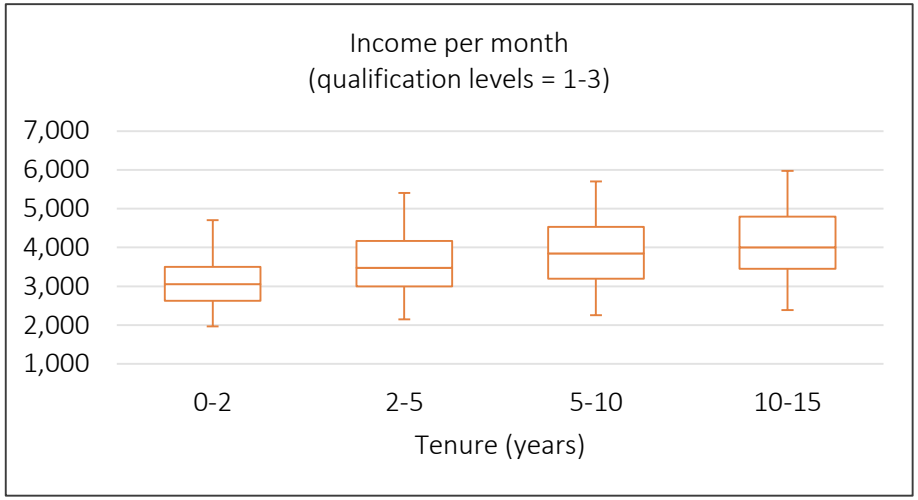
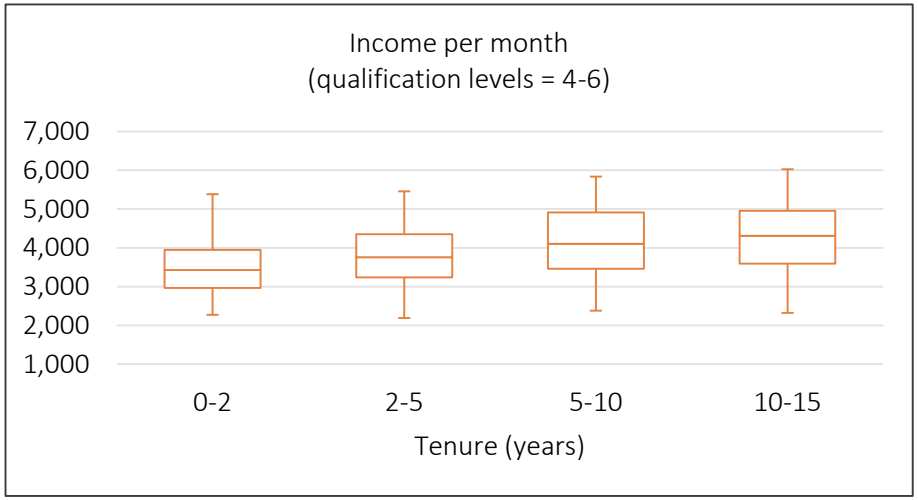
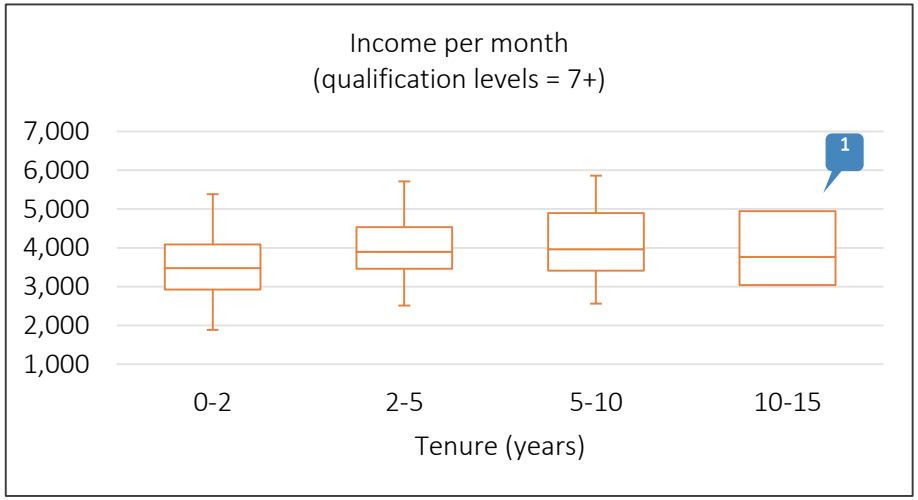
Experience has a similar impact on income for workers with all level of qualifications albeit that trained employees may continue to see modest income growth after their 10th year.

Industry experience on income in the dairy farming industry









[1] Whiskers are not shown to protect confidentiality.
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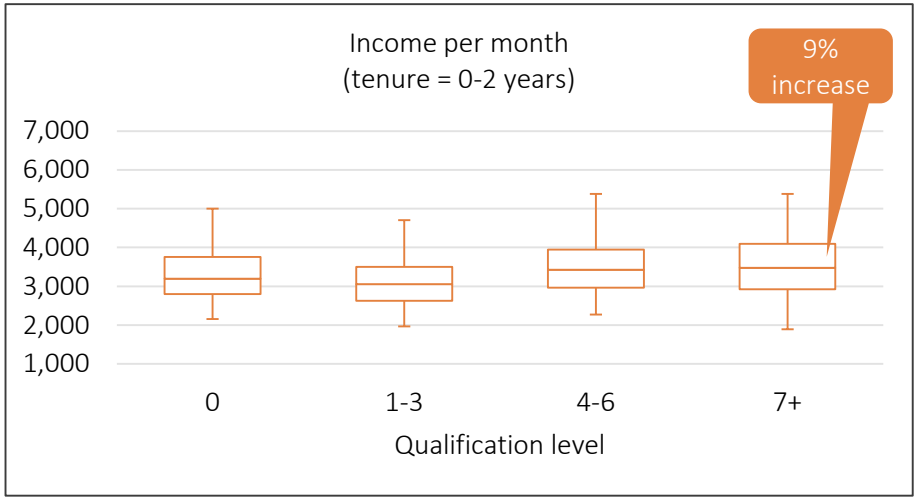
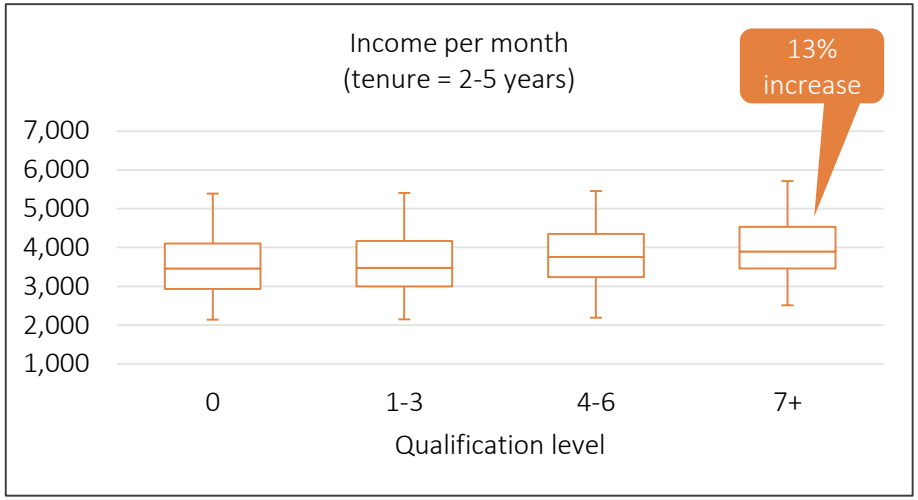
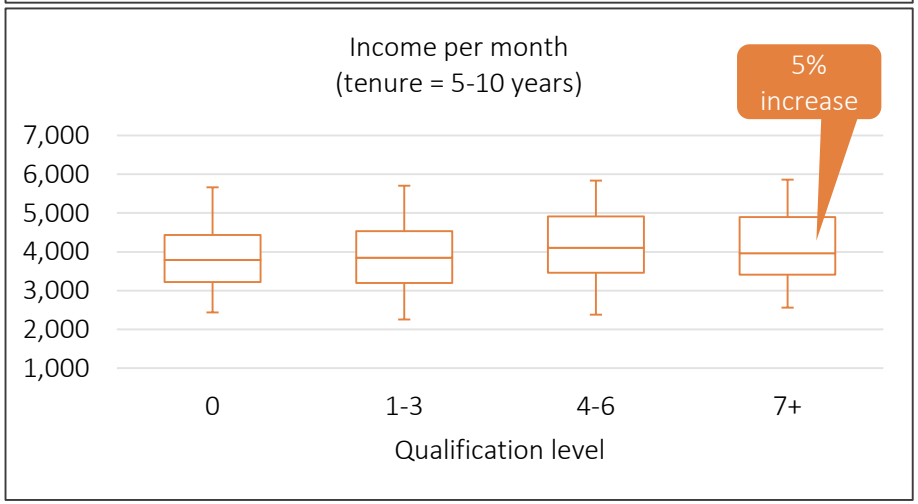
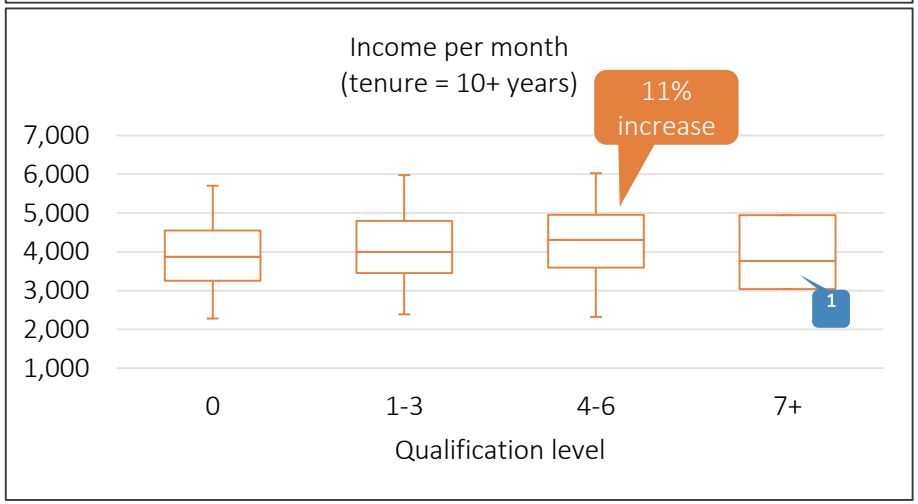
Income also increases with qualification levels, but to a lesser extent than with experience. The gaps between the average earnings of untrained workers and degree-qualified employees is between 5 and 15%. Importantly though, this analysis does not consider the transition to self-employment that is a strong feature of dairy farming careers. It is possible that self-employed dairy farmers will earn more than their salaried peers and that higher qualifications will correlate well with self-employment.

Qualification level on income in the dairy farming industry









[1] Whiskers are not shown to protect confidentiality.

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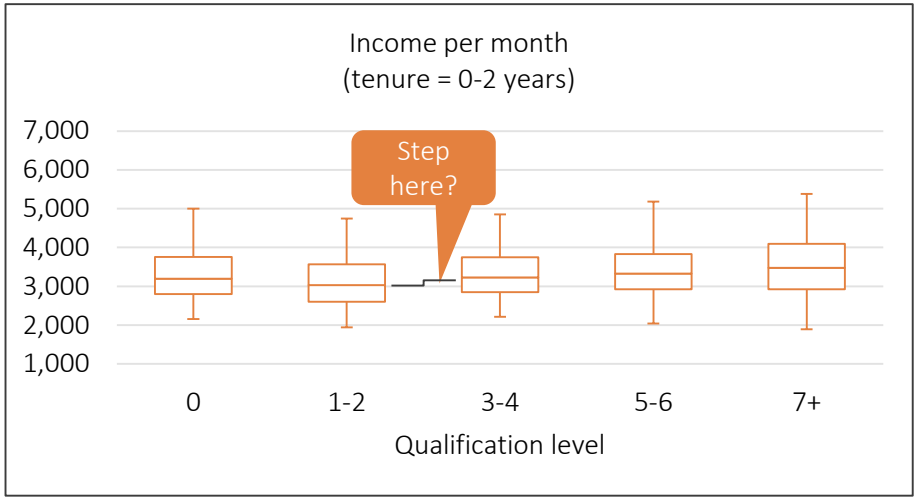
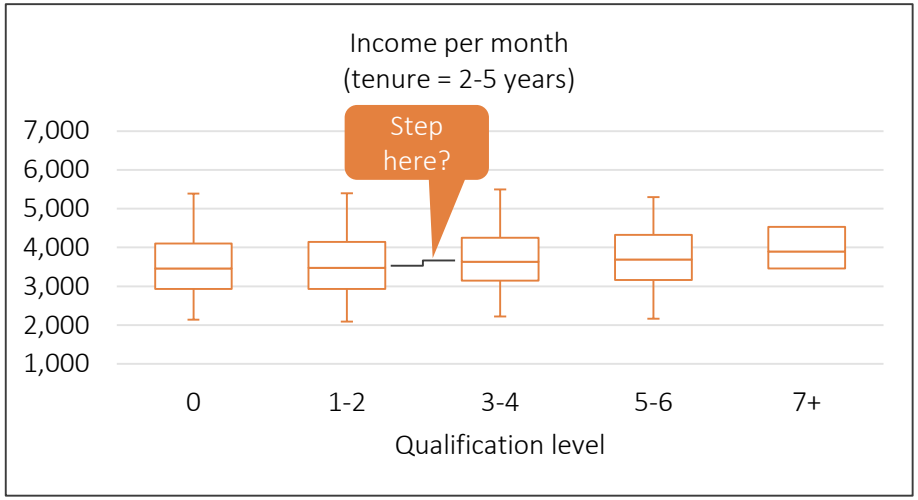
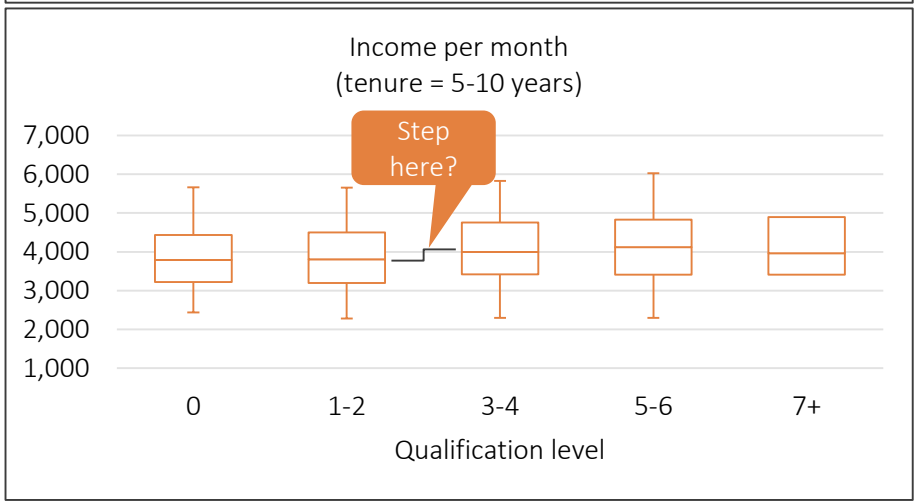
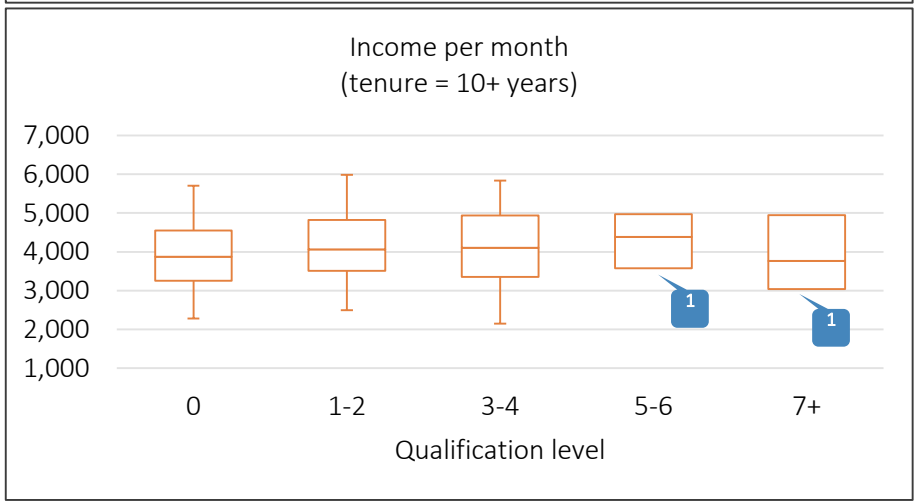
Regrouping qualifications in bands of two NZQA level (as opposed to the groupings used on the previous slide) hints that there is a step in income once employees are trained to level 3-4.

Qualification level on income in the dairy farming industry









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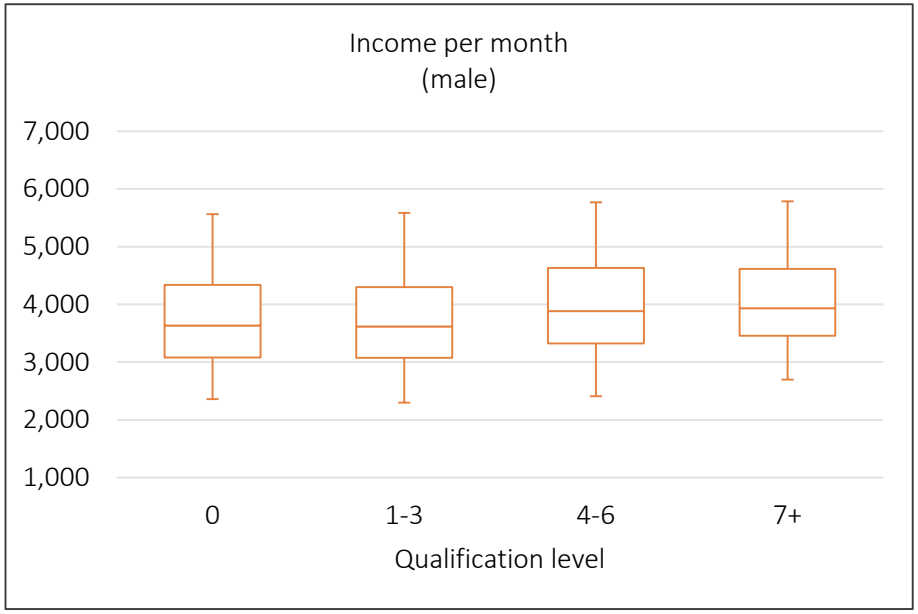
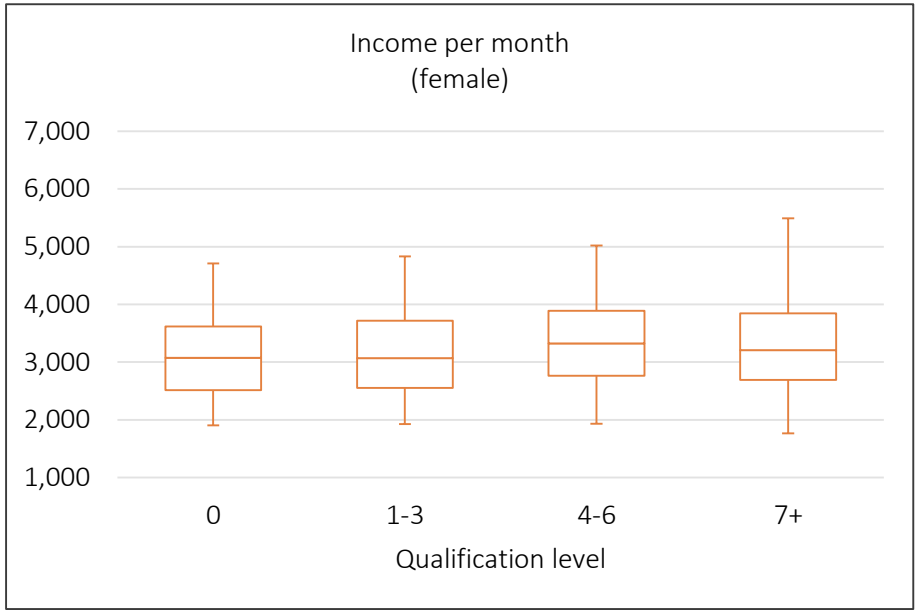
Male workers earn more than females across all levels of qualification. This may reflect differences in hours worked.

Gender on income in the dairy farming industry





The gap between income of male and female workers is less pronounced, although not eliminated, if only workers earning above $2,500/month are considered (analysis not shown here). This may indicate that differences in hours worked explain much of the gender gap.

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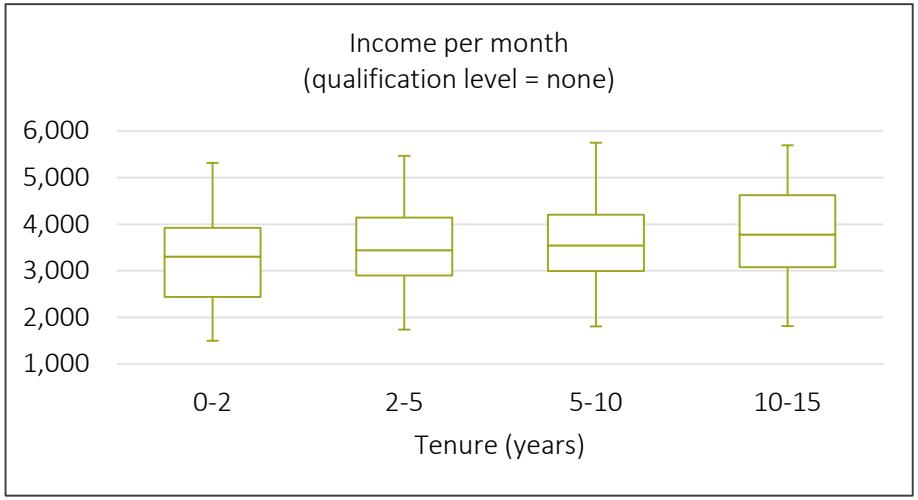
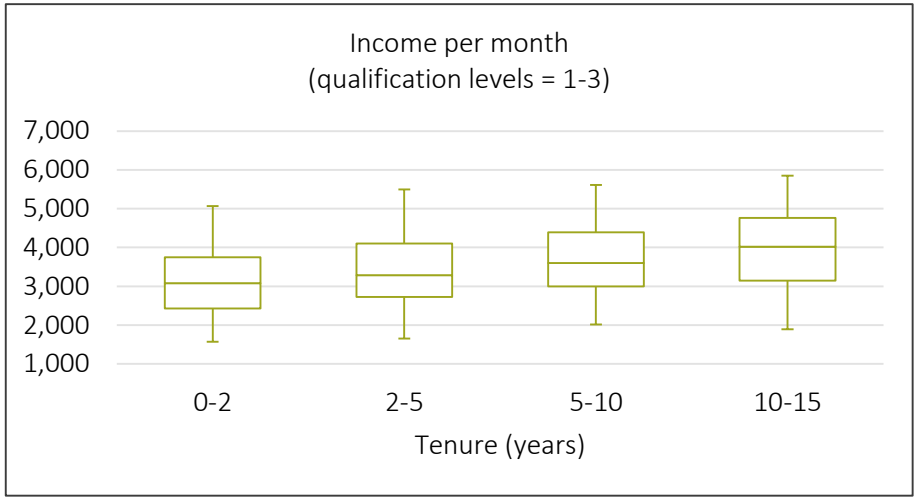
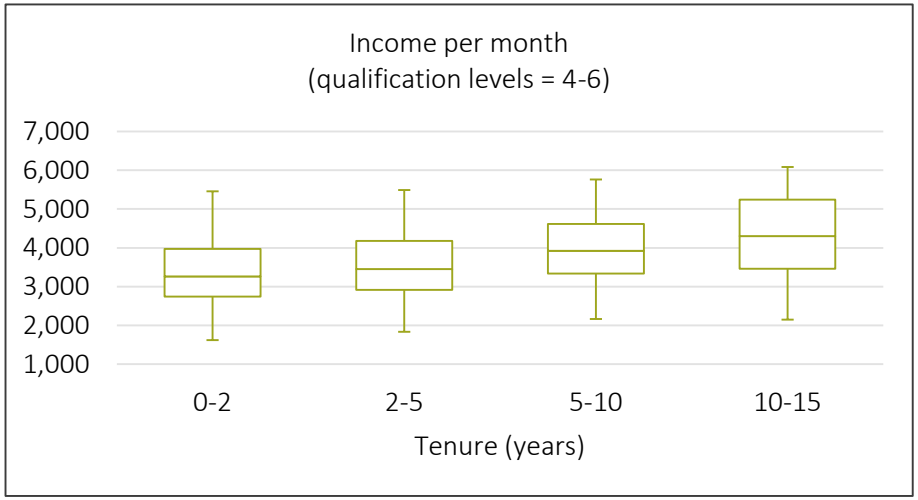
Contents

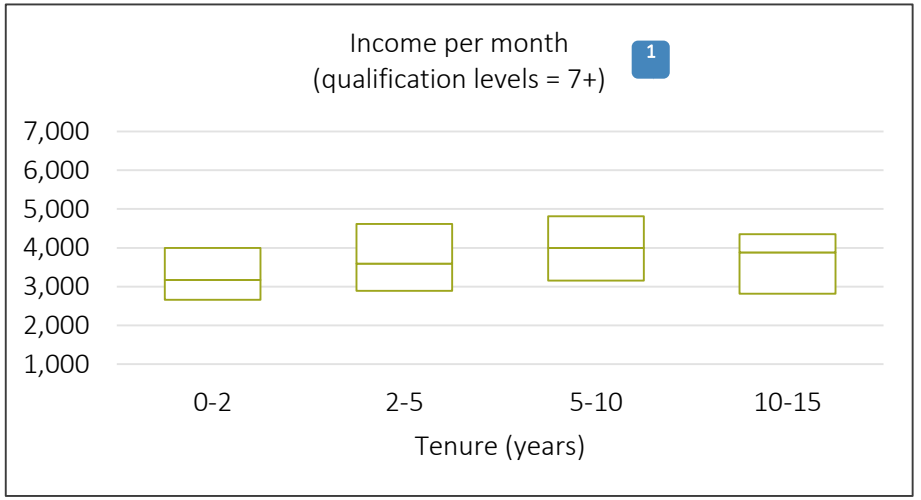
The beef & sheep farming industry shares a similar trend as the dairy farming industry, where income rises with industry experience in most cases.

Industry experience on income in the beef & sheep farming industry









[1] Whiskers are not shown to protect confidentiality.

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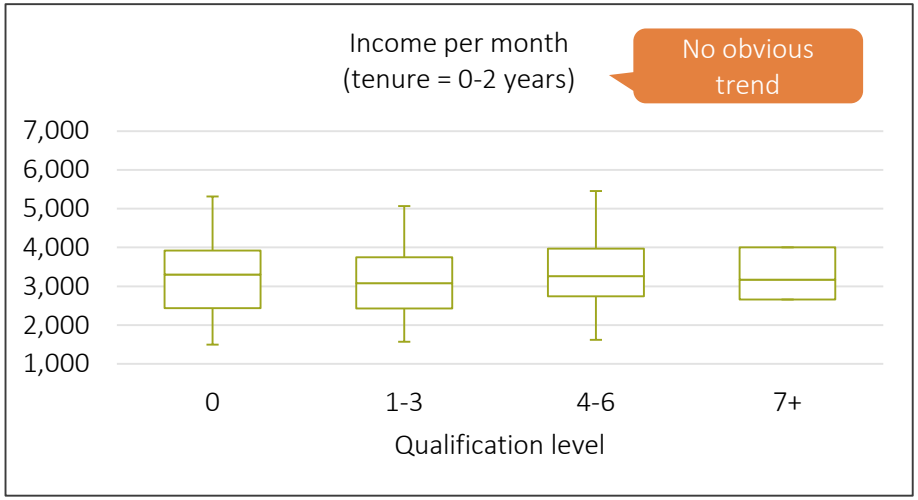
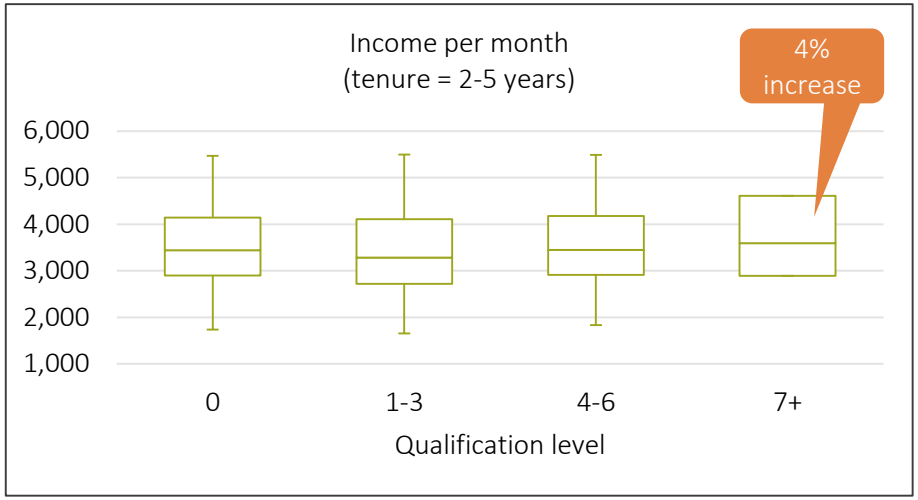
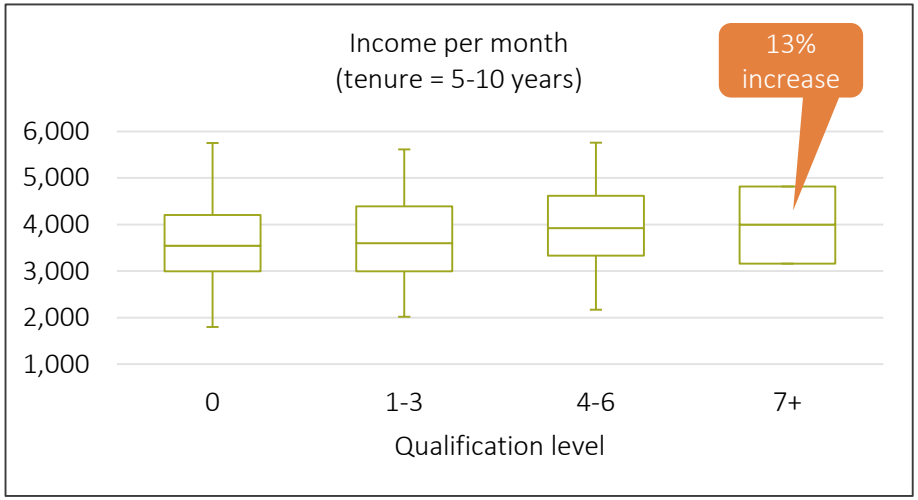
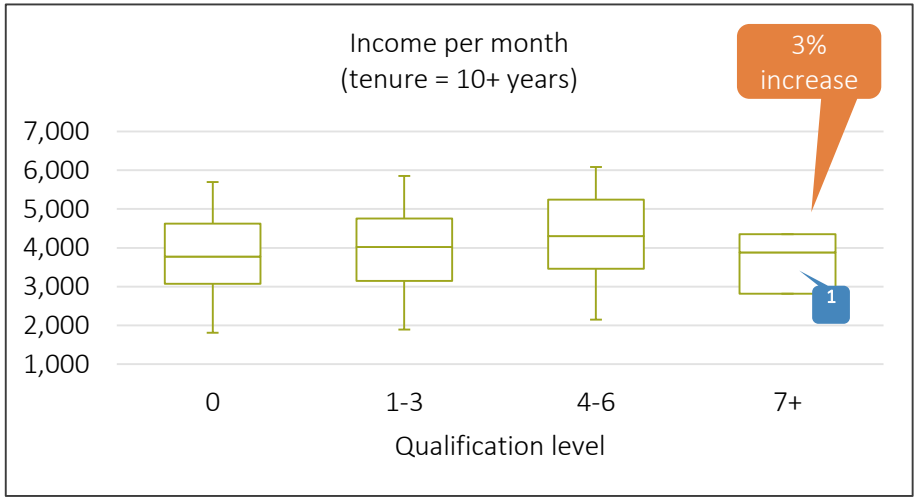
Again, the beef & sheep farming industry shares a similar trend as the dairy farming industry, with income positively, but weakly, correlated with qualification level.

Qualification level on income in the beef & sheep farming industry









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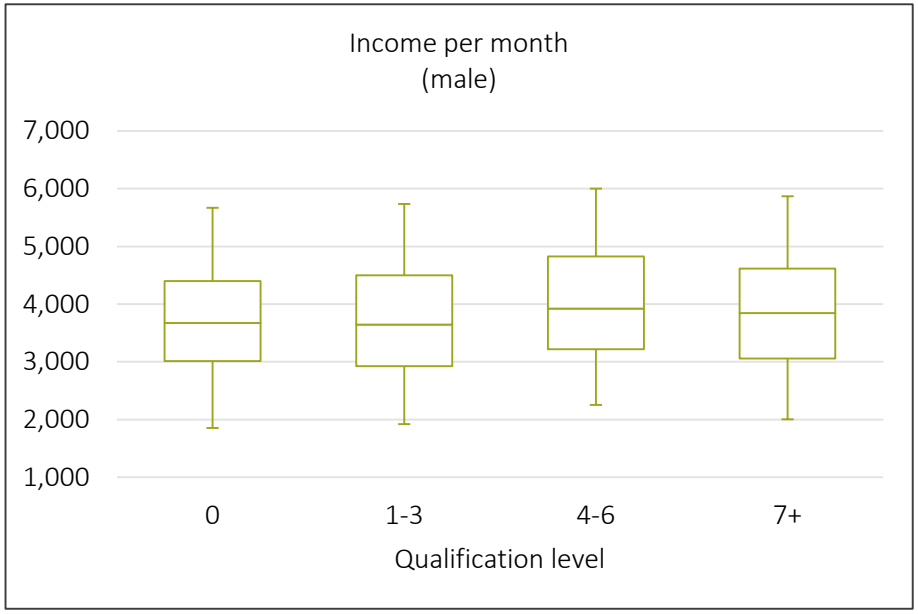
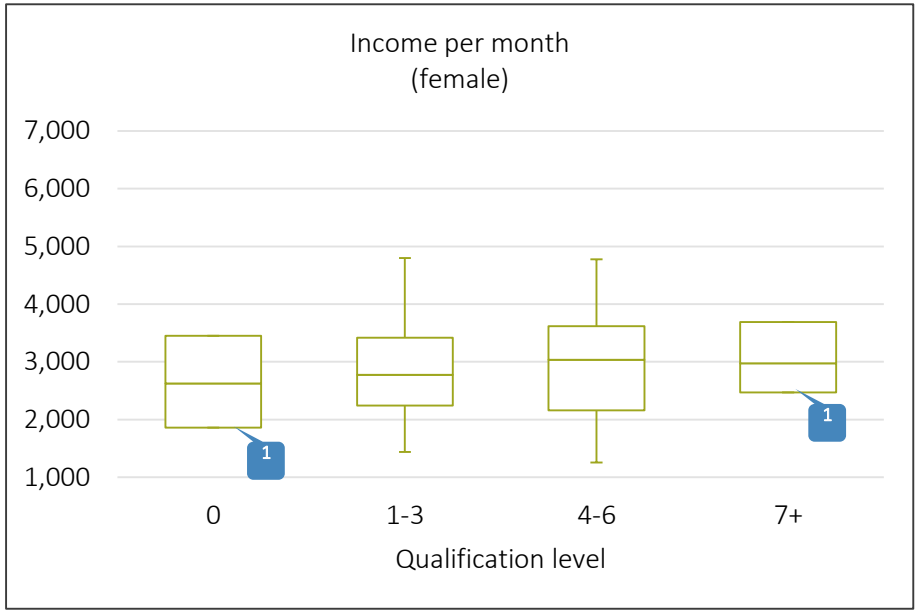
As for dairy farming, in the beef & sheep farming industry the male workforce appears to earn more than its female counterpart.

Gender on income in the beef & sheep farming industry





[1] Whiskers are not shown to protect confidentiality.

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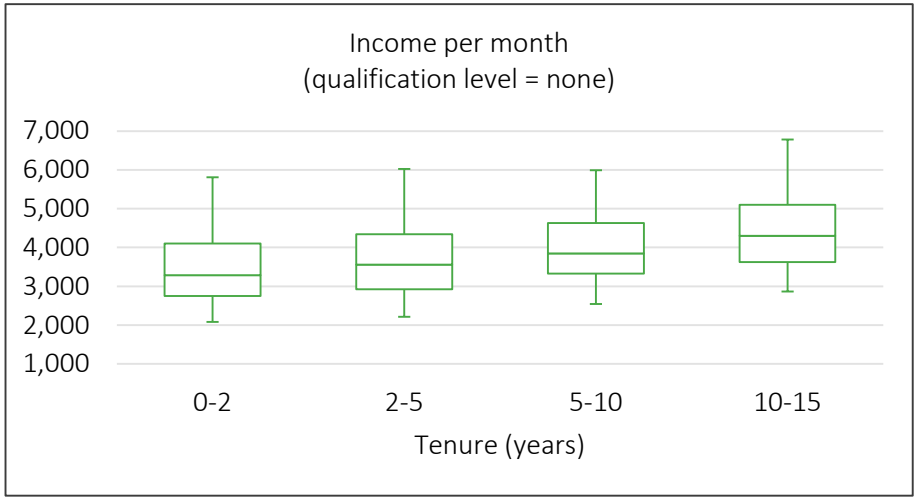
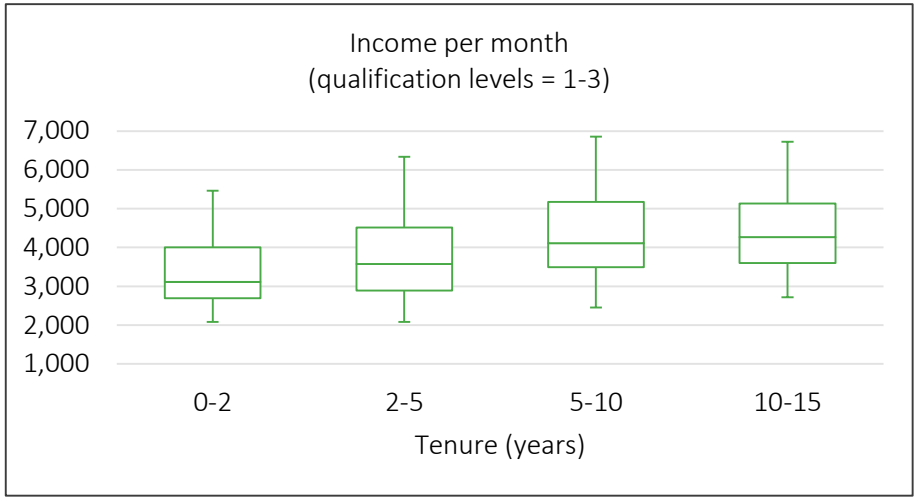
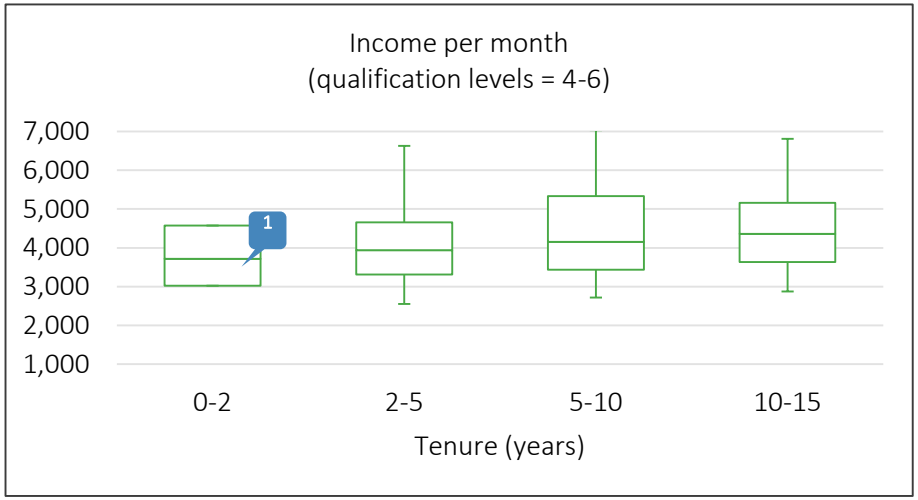
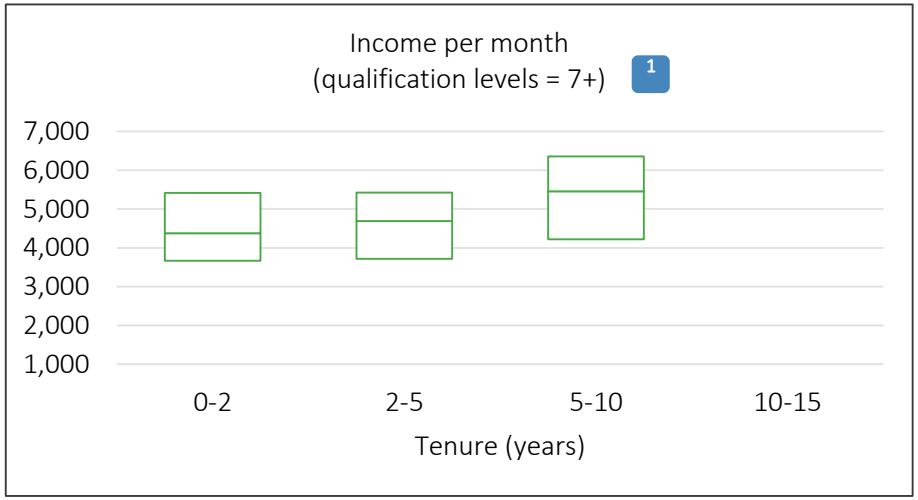
The forestry industry also shares a similar trend as the dairy and beef & sheep farming industries, where income rises with industry experience.

Industry experience on income in the forestry industry









[1] Whiskers are not shown to protect confidentiality.
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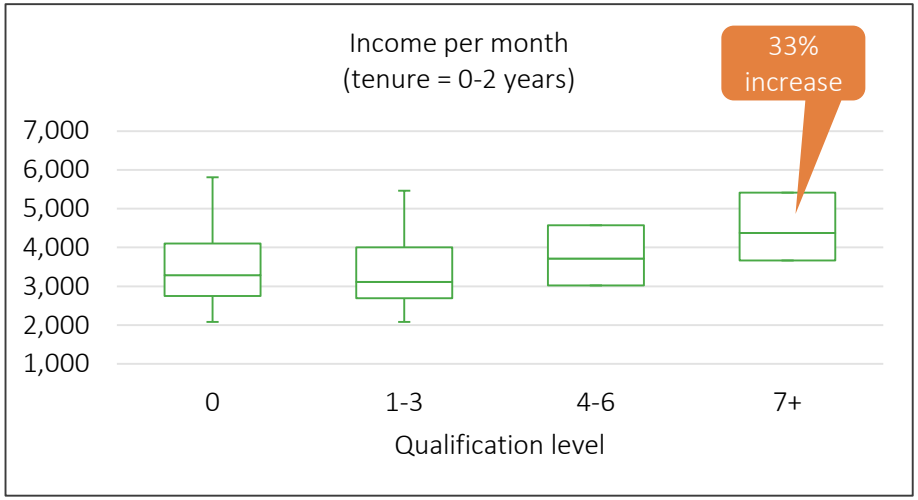
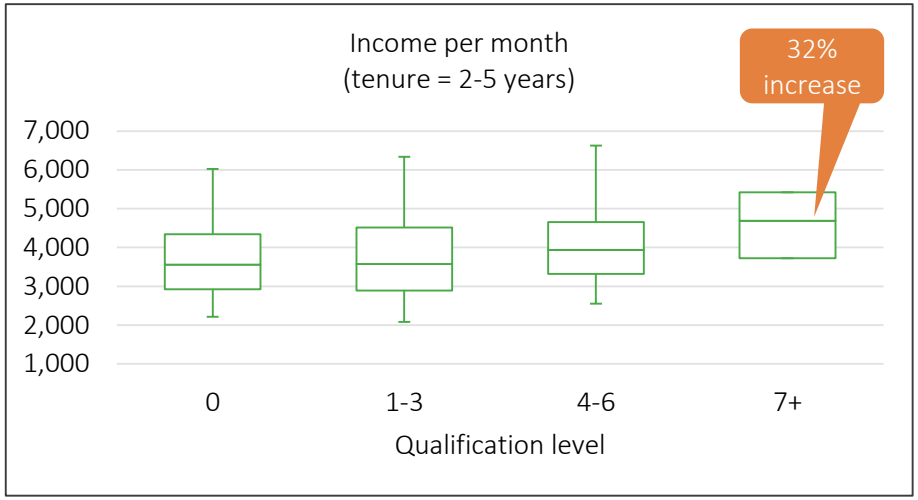
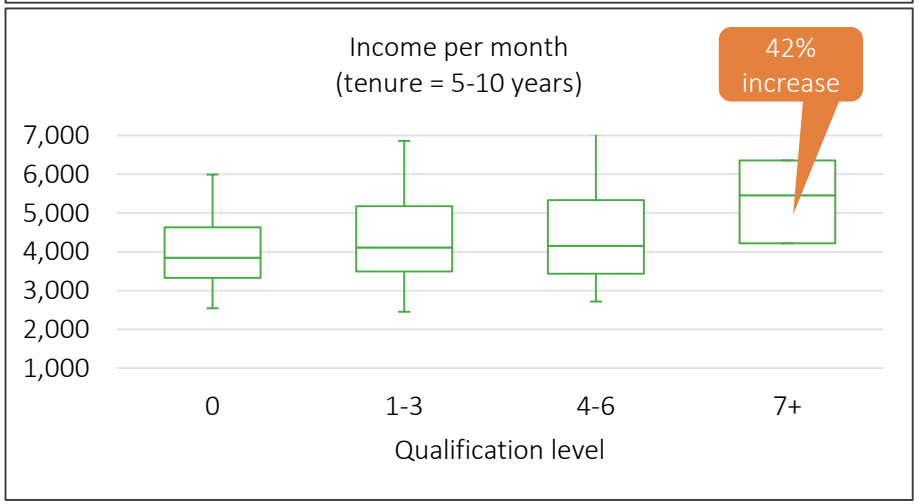
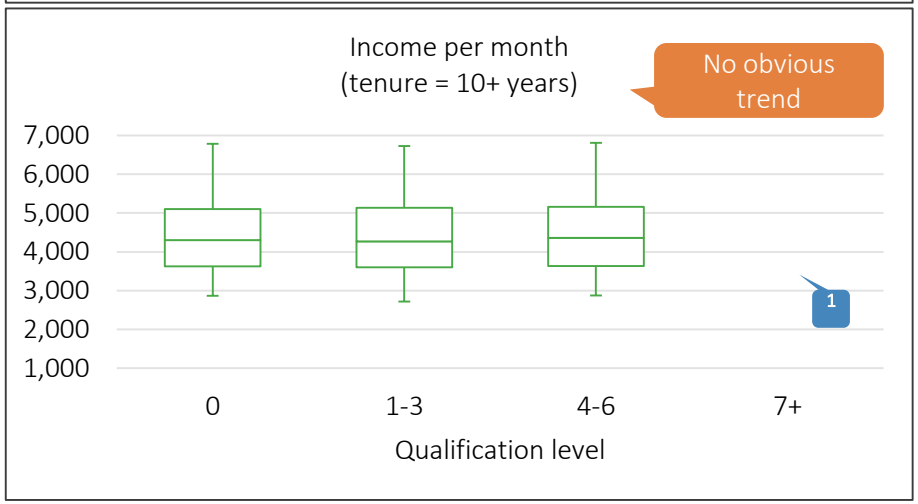
The income in forestry industry appears to be more strongly correlated with qualification compared to the dairy and beef & sheep farming industries. The strong increase in income for Level 7+ qualification needs to be viewed with caution though, due to the small sample size. Overall, a stronger correlation between income and industry experience is still observed.

Qualification level on income in the forestry industry









[1] Whiskers are not shown to protect confidentiality.

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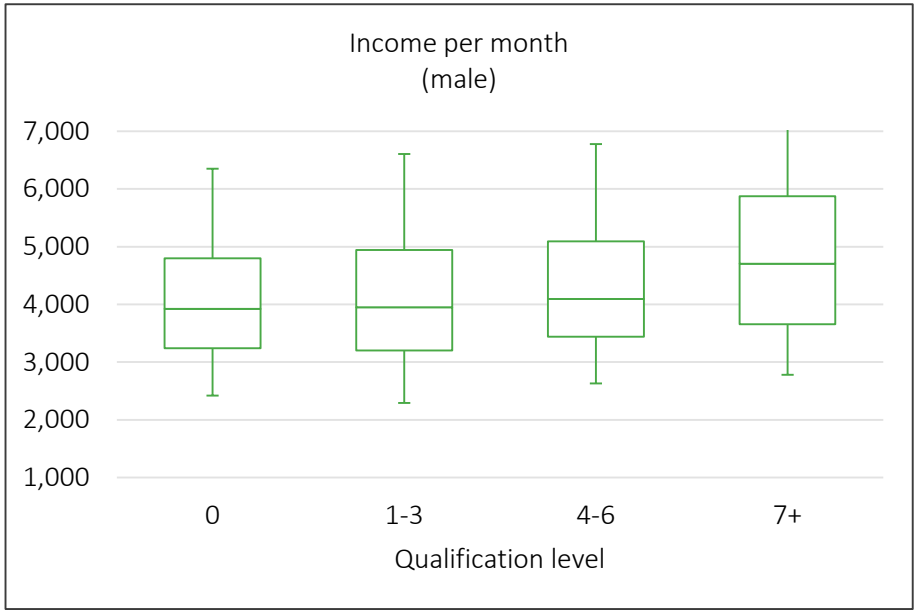
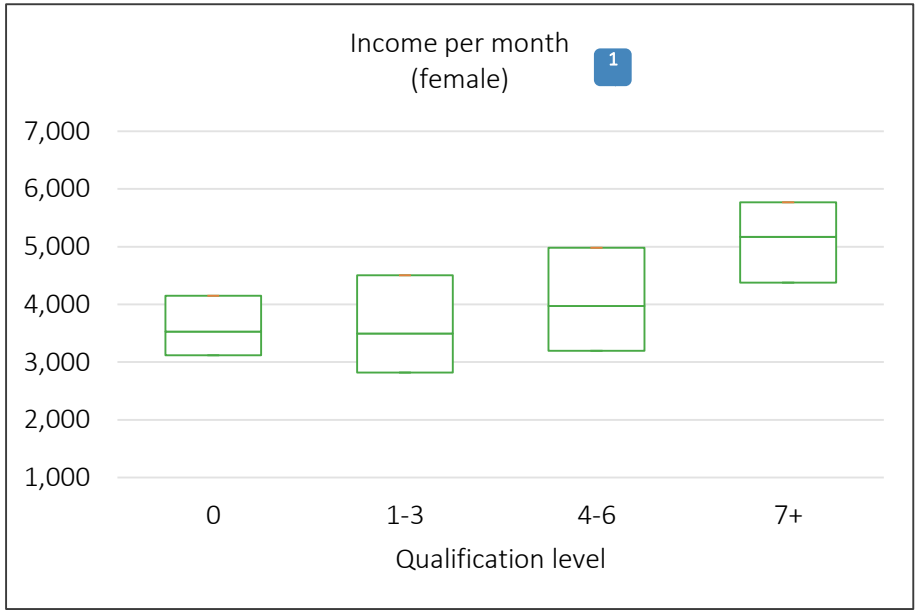
Consistent with the other primary sectors, female workers appear to be earning less than male workers in the forestry industry.

Gender on income in the forestry industry





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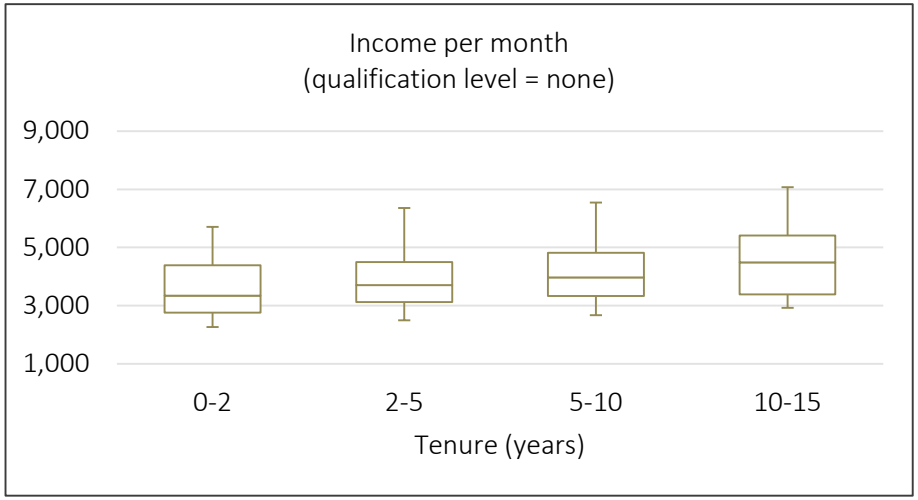
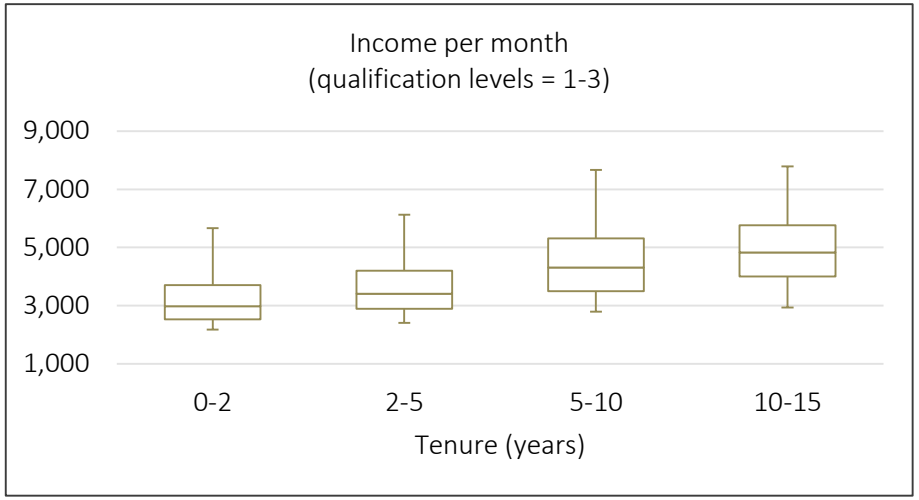
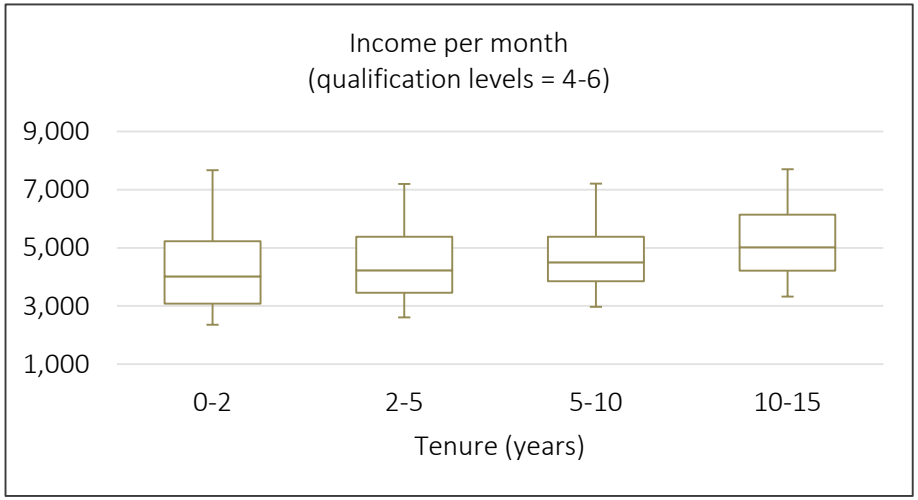
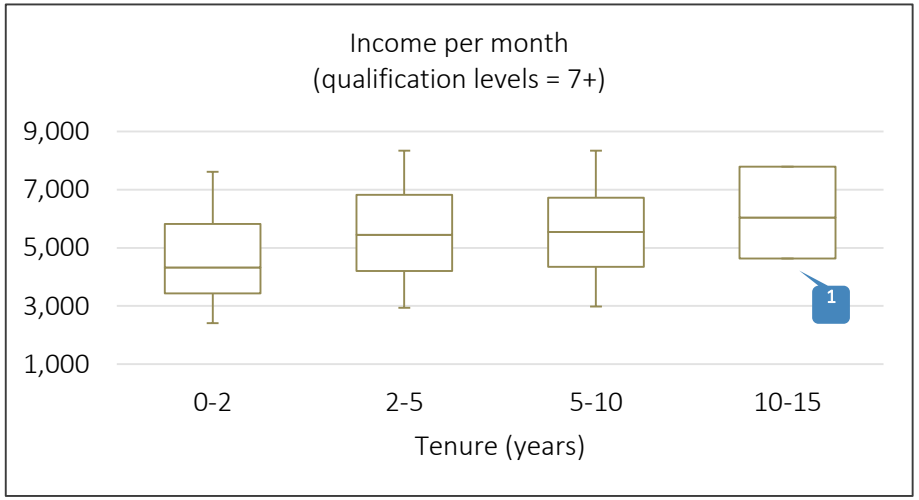
Experience has a similar positive relationship with income for workers across different levels of qualifications for the carpentry industry as for the primary industries.

Industry experience on income in the carpentry industry









[1] Whiskers are not shown to protect confidentiality.

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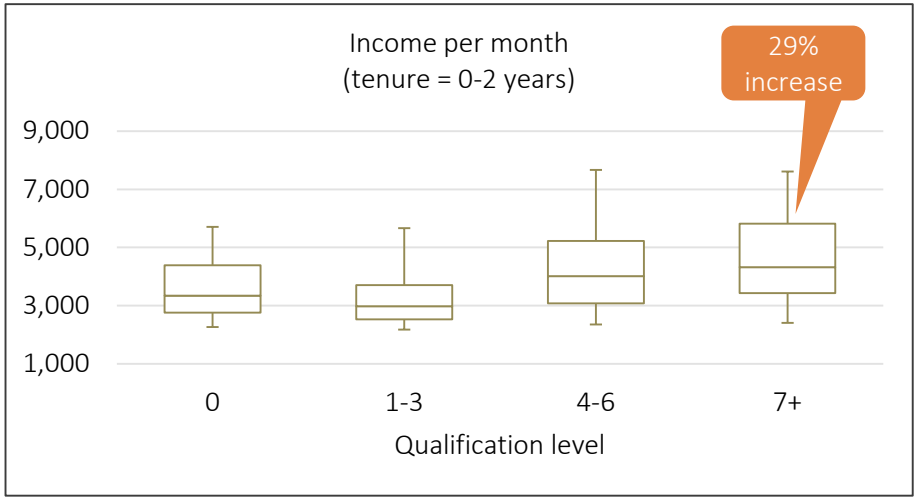
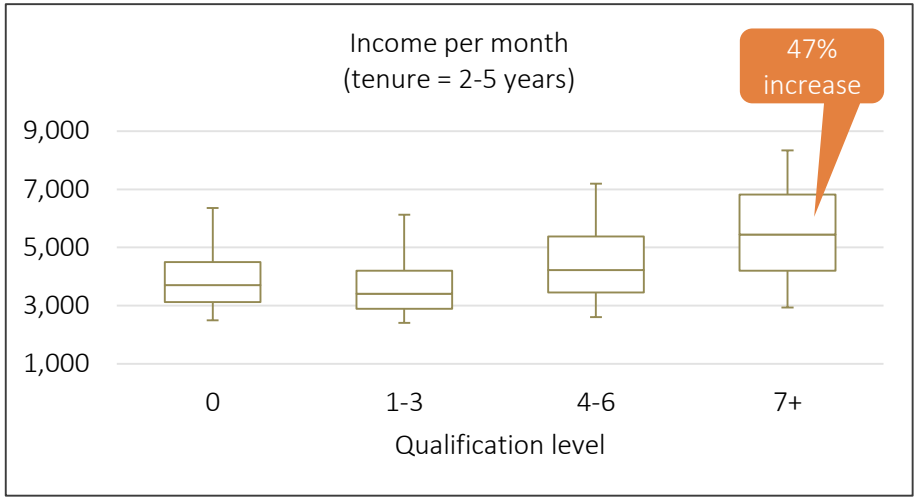
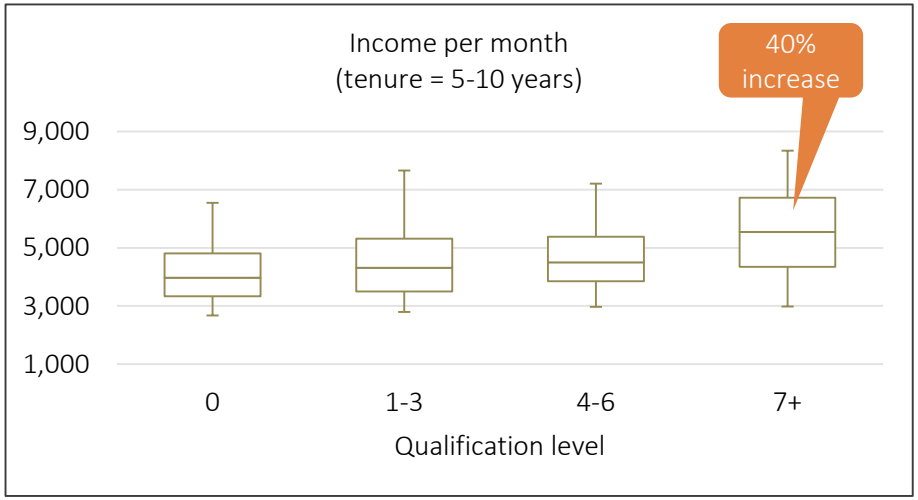
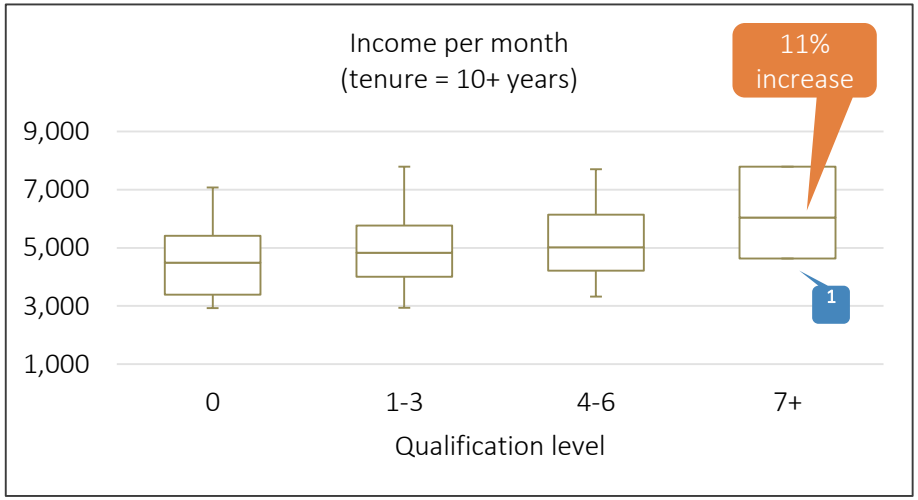
Carpenter's incomes increases more with qualification levels, that workers in the primary industries.

Qualification level on income in the carpentry industry







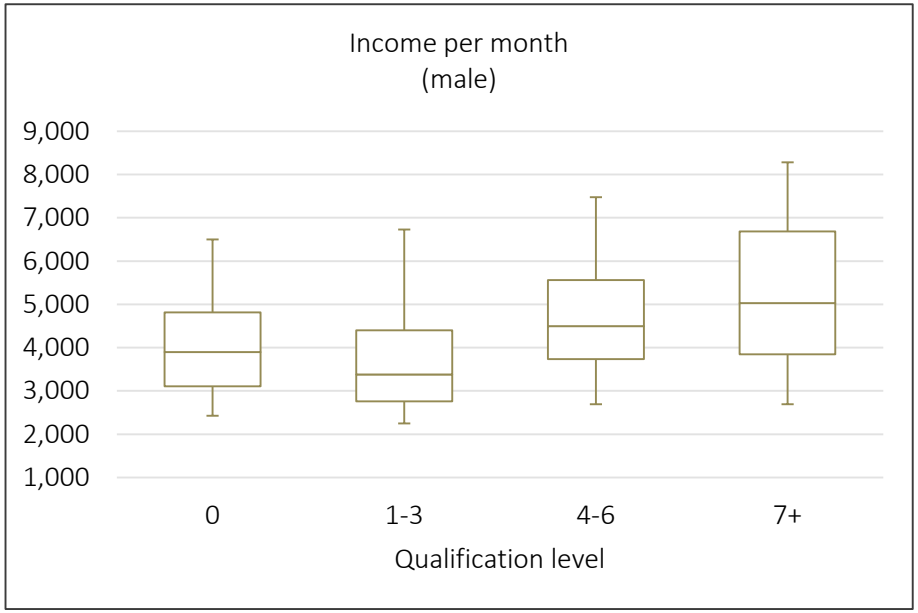


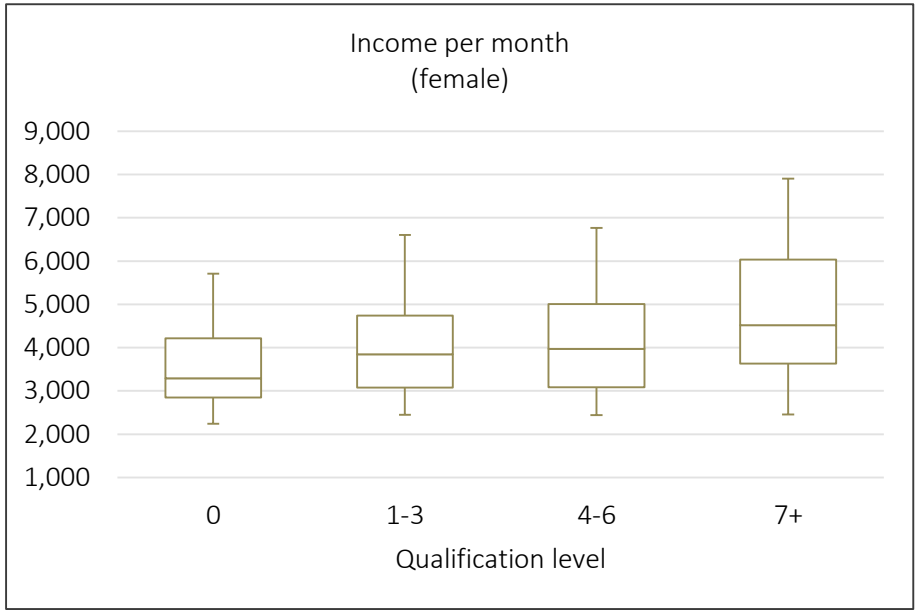
[1] Whiskers are not shown to protect confidentiality.

Source: …\Checked\Denny\15-07-16\20160714 ROI.xls

Male workers in carpentry also earn more than female workers across all levels of qualification.

Gender on income in the carpentry industry



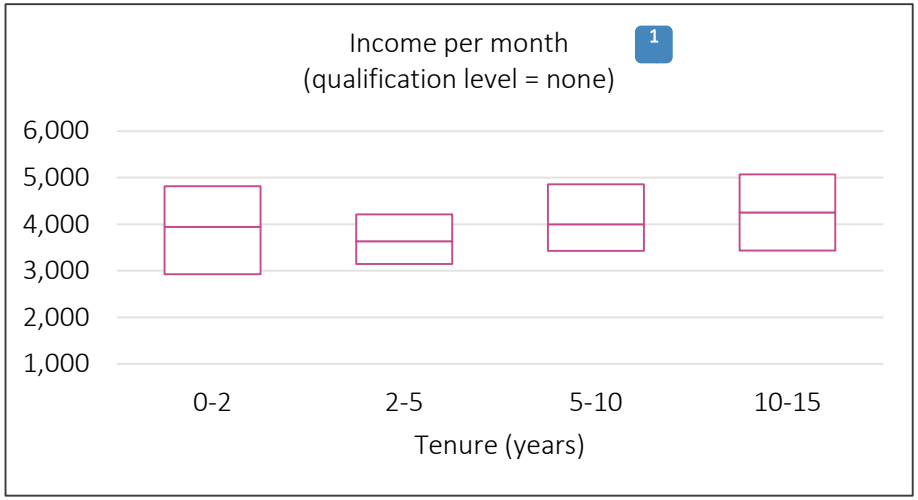


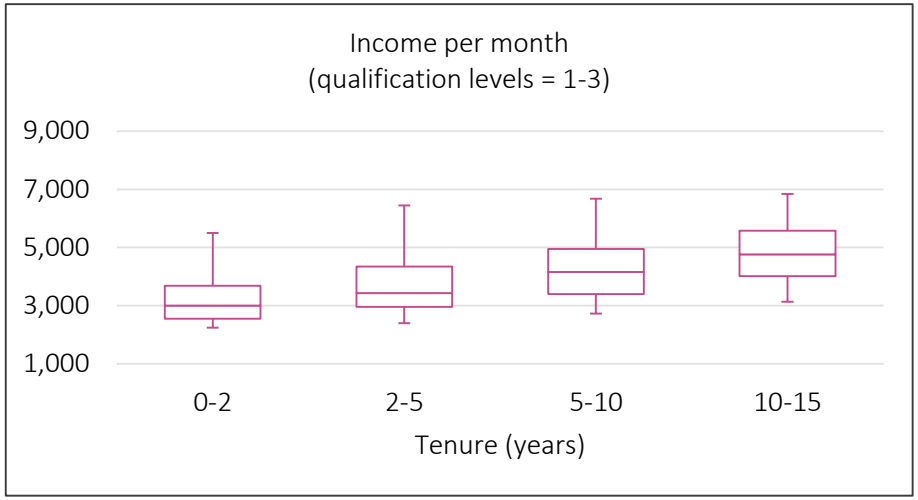
[1] Whiskers are not shown to protect confidentiality.
Source: …\Checked\Denny\15-07-16\20160714 ROI.xls

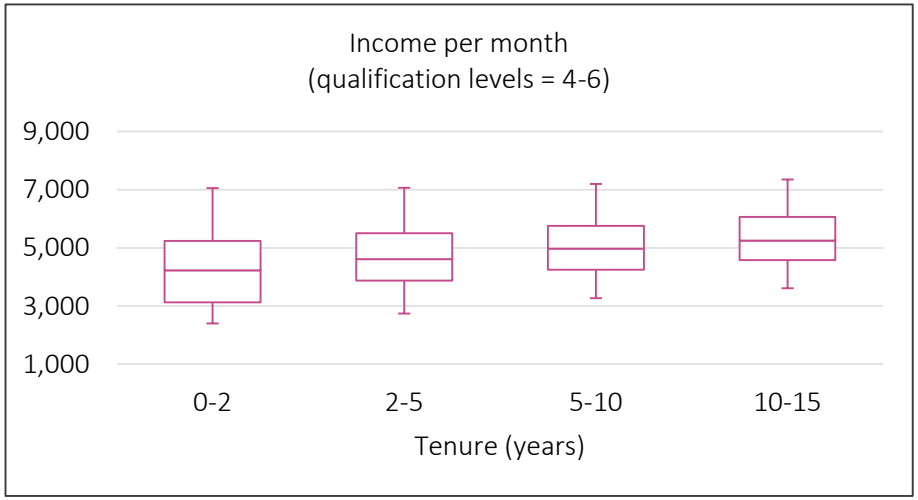
Contents

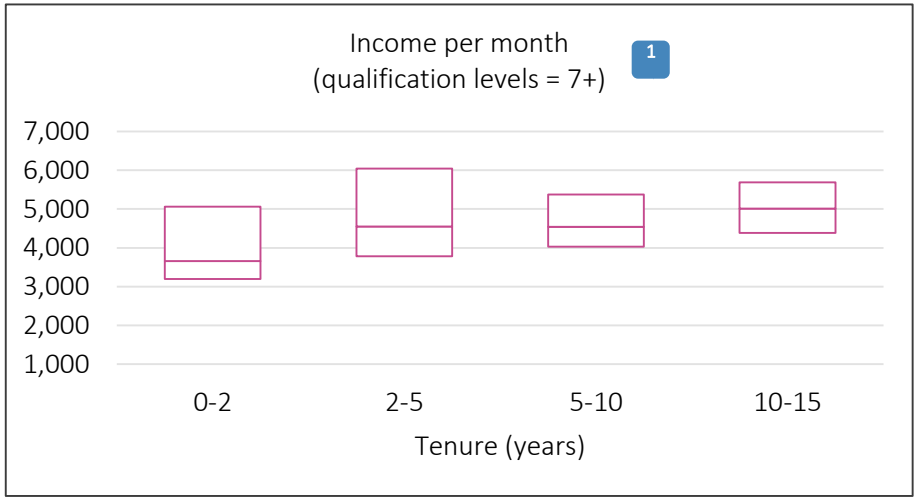
Consistent with the other industries, income rises with industry experience.

Industry experience on income in the electrical service industry





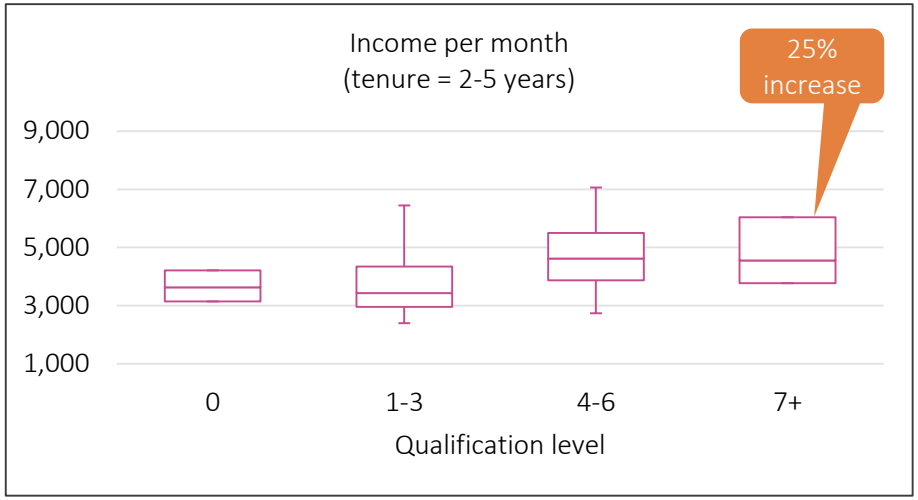


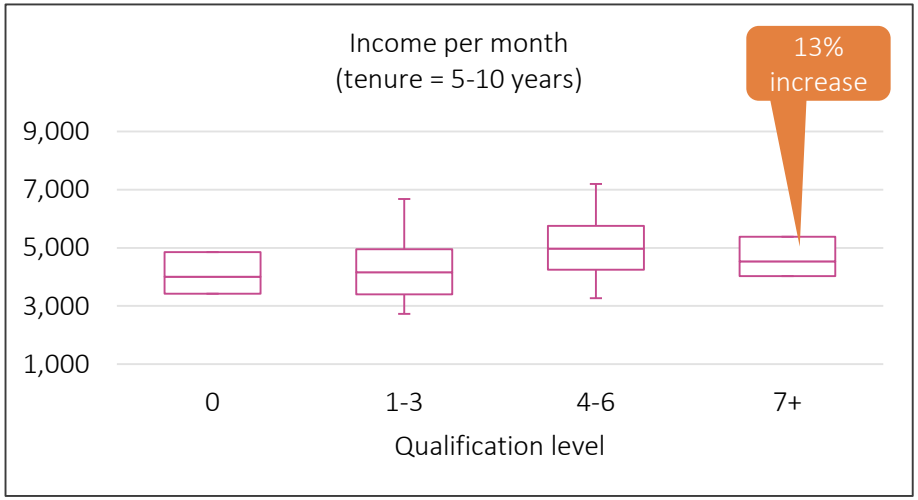


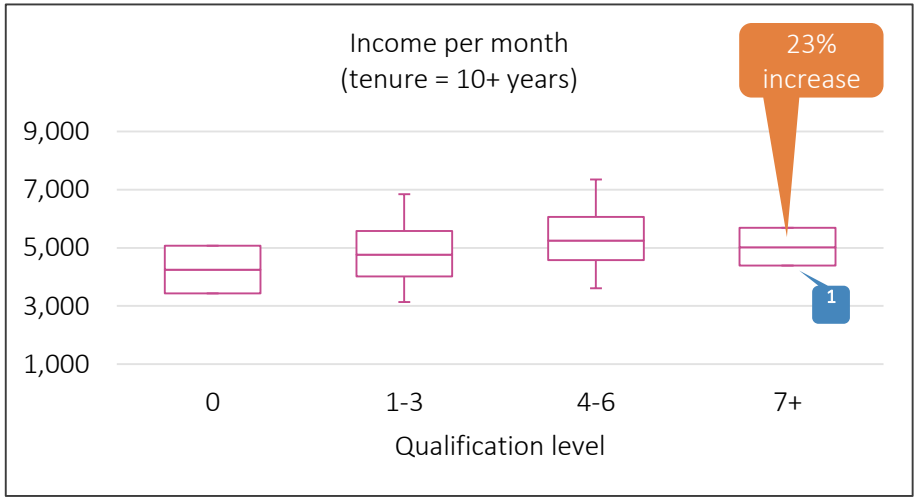
[1] Whiskers are not shown to protect confidentiality.
Source: …\Checked\Denny\15-07-16\20160714 ROI.xls

Like the carpentry industry, income in the electrical service industry also appears to be more strongly correlated with qualification level when compared to the farming industries.

Qualification level on income in the electrical service industry





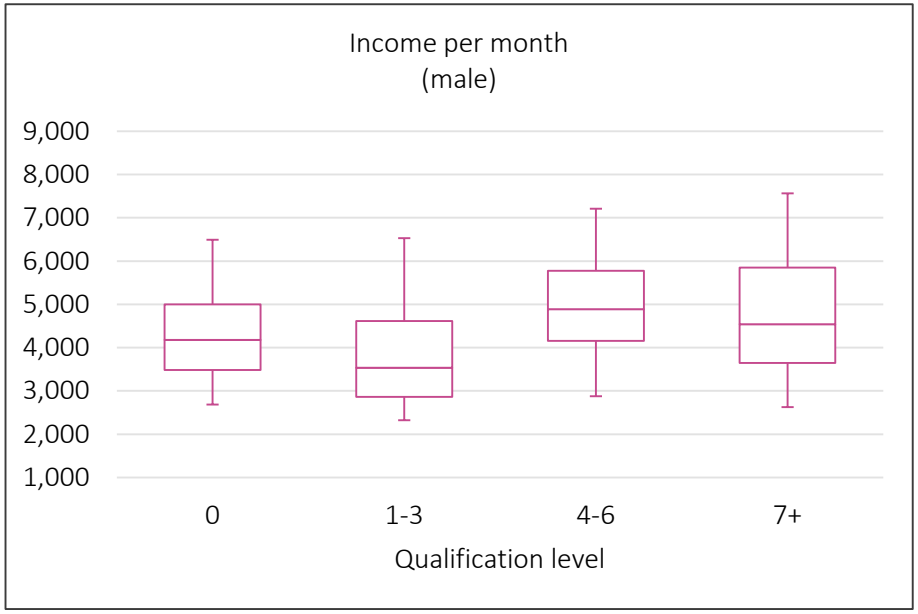


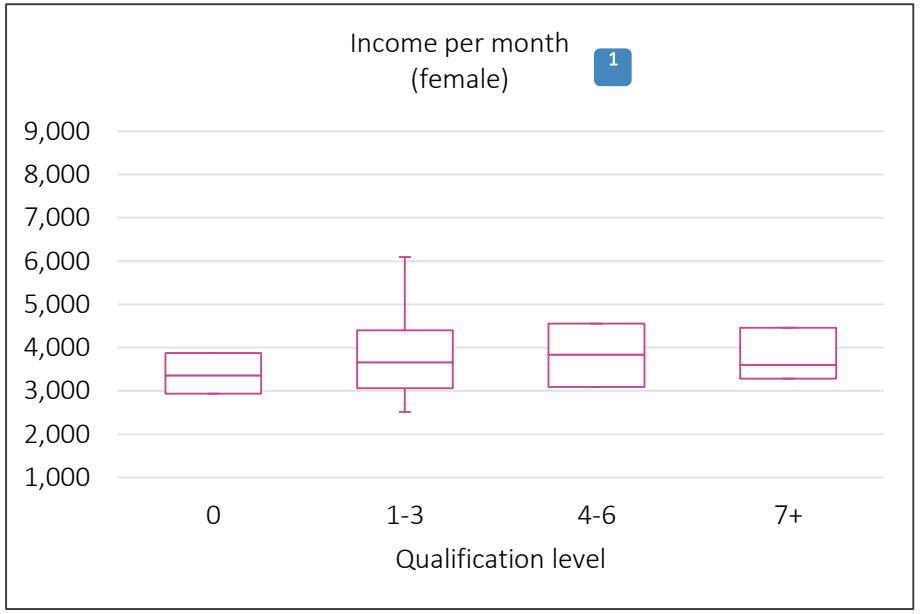
[1] Whiskers are not shown to protect confidentiality.

Source: …\Checked\Denny\15-07-16\20160714 ROI.xls

Similarly, male workers earn more than female workers across all levels of qualification in the electrical service industry.

Gender on income in the electrical service industry



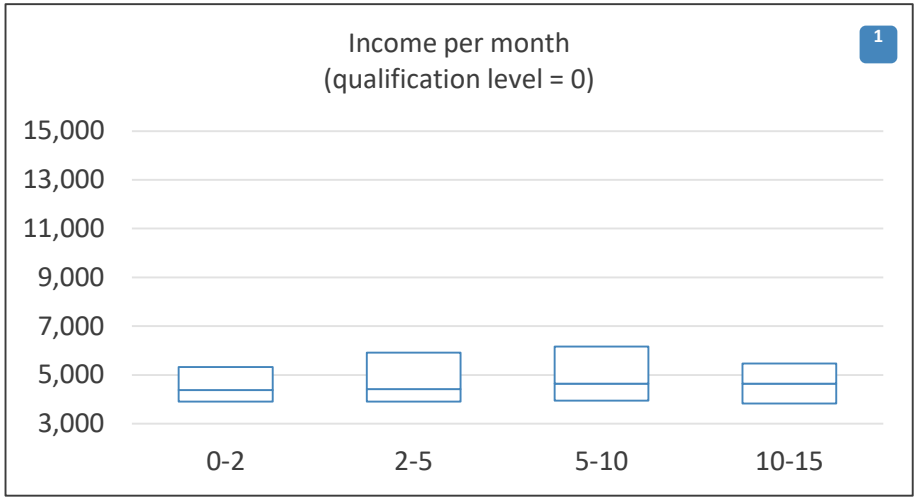


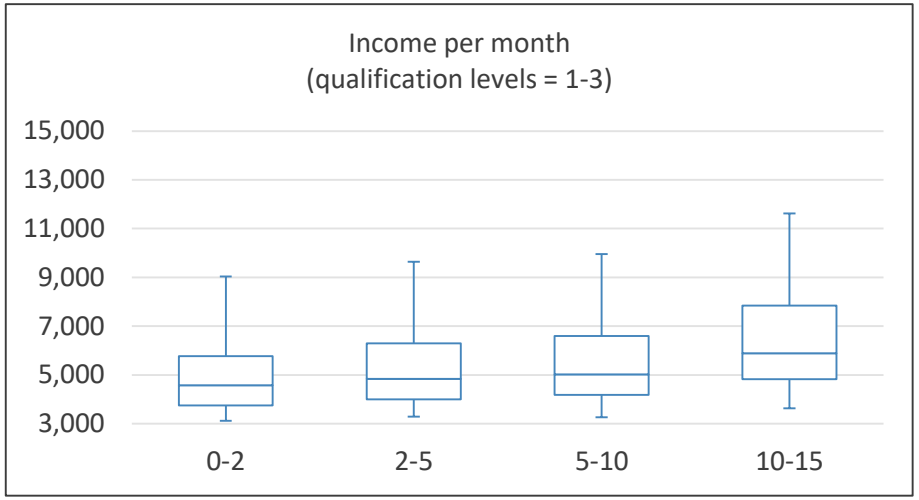
[1] Whiskers are not shown to protect confidentiality.
Source: …\Checked\Denny\15-07-16\20160714 ROI.xls

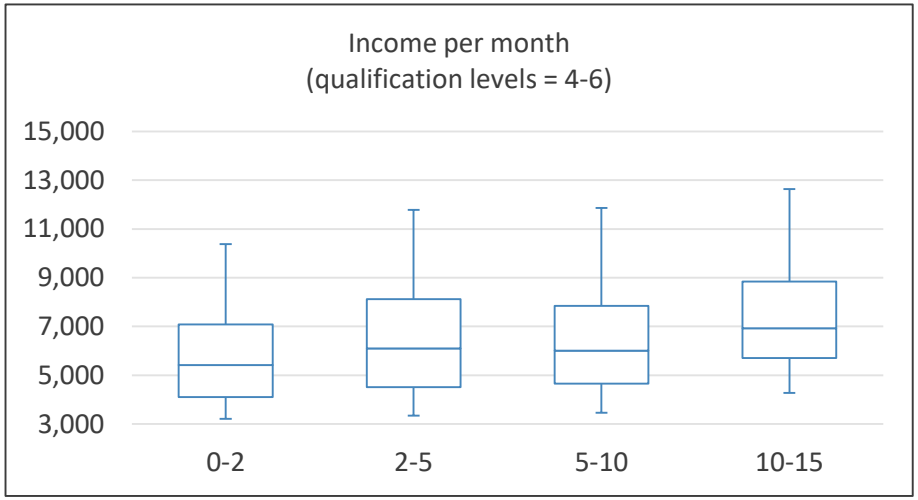
Contents

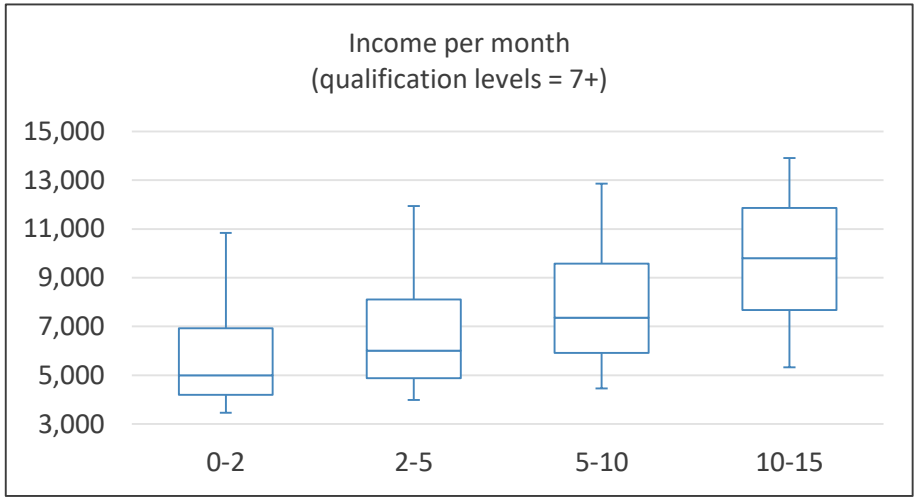
Experience is also well-rewarded for degree qualified engineers but their untrained co-workers get little benefit from their experience.

Industry experience on income in the engineering design and consultancy industry





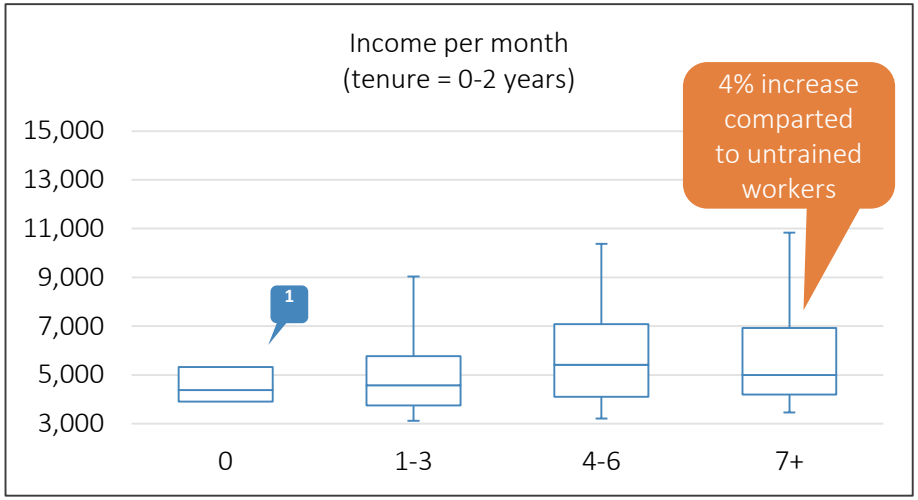


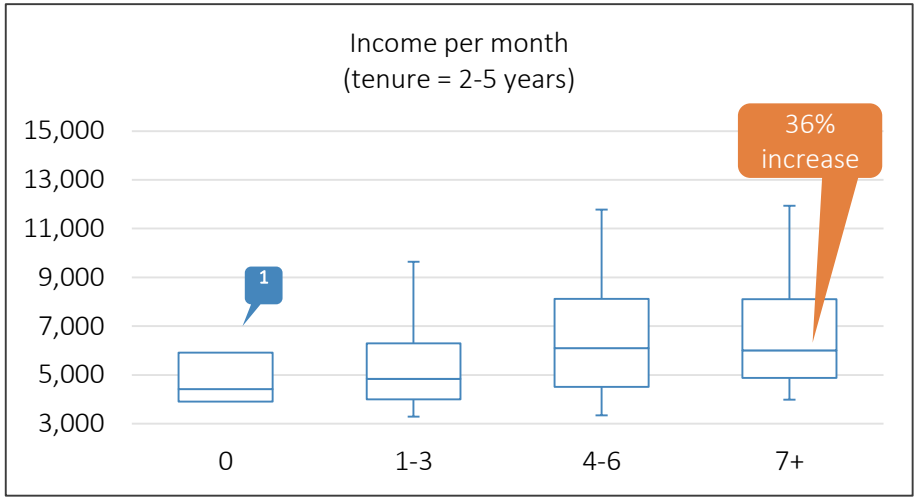


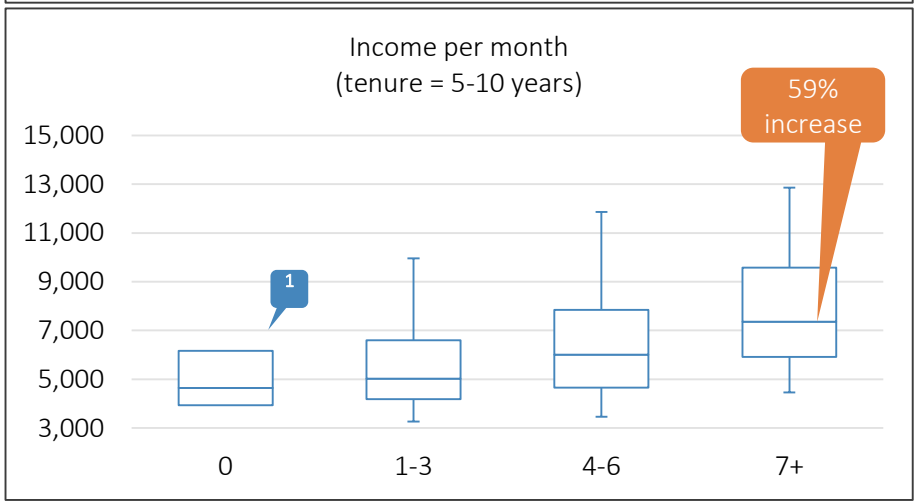
[1] Whiskers are not shown to protect confidentiality.
Source: …\Checked\Denny\17-05-16\RoI.xls

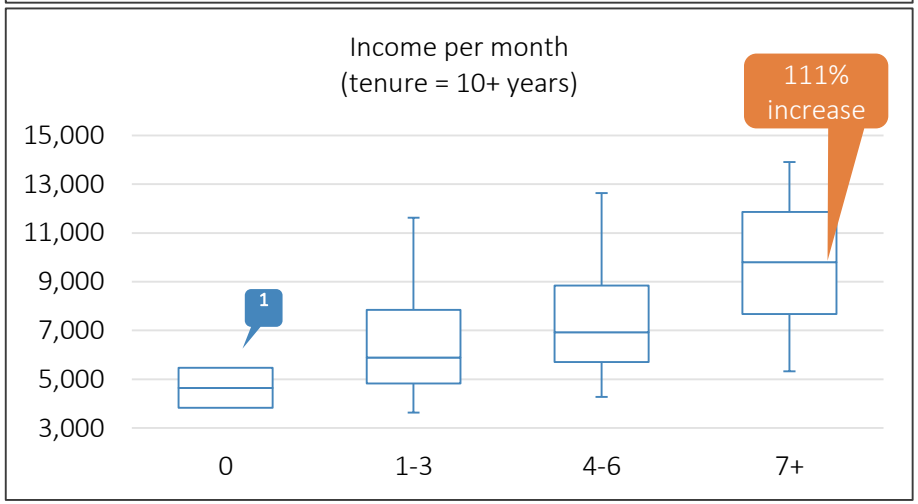
The dependence of income on qualification level in engineering design and consultancy is stronger than that in the other industries.

Qualification level on income in the engineering design and consultancy industry





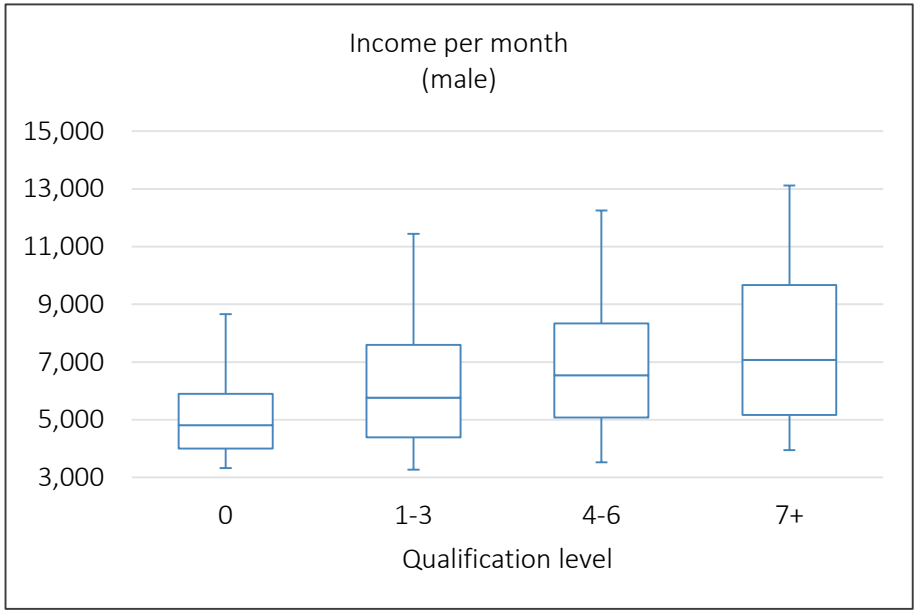


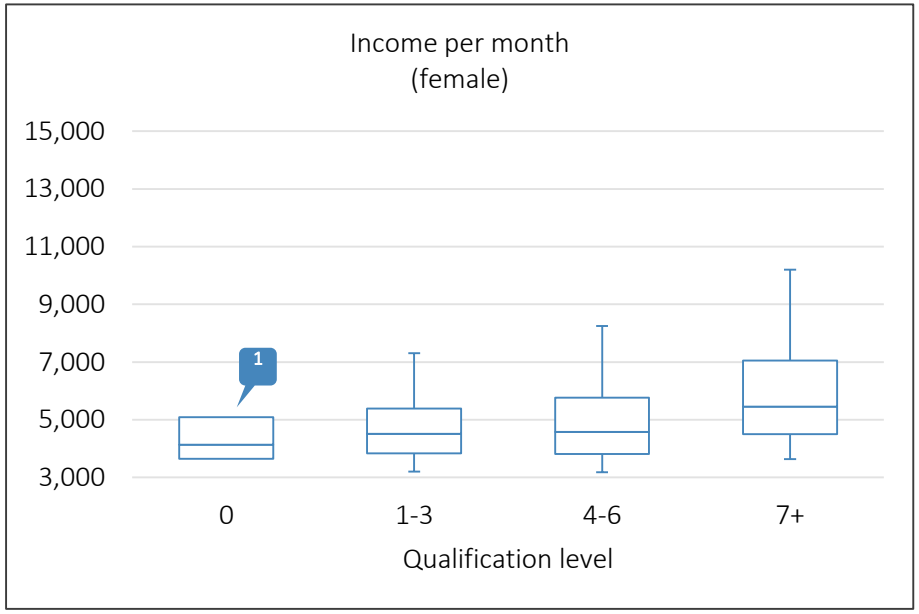


[1] Whiskers are not shown to protect confidentiality.
Source: …\Checked\Denny\17-05-16\RoI.xls

A similar trend can be observed in engineering consultancy and design where male employees earn more compared to female employees. Both groups earn more with higher qualification levels.

Gender on income in the engineering design and consultancy industry





[1] Whiskers are not shown to protect confidentiality.

Source: …\Checked\Denny\17-05-16\RoI.xls

Contents

One of the aims of this report is to quantify the relationship between individual earnings & qualification levels in different industries. To accomplish this, we analyse the correlation between income and potentially important individual attributes - age, sex, tenure (experience), and qualification level. By performing a regression analysis on income with these attributes and using *LMG* relative important metric[1], we can gain a crude estimate of the contribution of qualification levels to the observed variation in income.

Approach to estimate the relationship between individual earnings and qualification levels

Included to account for any impact of non-industry experience

Include only industry tenure

Income ($/month)	Age (years)	Sex	Industry experience (years)	Qualification level (NZQA level)
3,000	*28*	*Male*	*5*	*6*
5,000	*35*	*Female*	*10*	*3*
. . .				
2,000	*18*	*Male*	*1*	*3*

Examples are made-up data for the purpose of illustration

$$\text{INCOME} = a_0 + a_1\,\text{age} + a_2\,\text{sex} + a_3\,\text{tenure} + \mathbf{a_4}\,\text{QUALIFICATION} + \ldots$$

$$\boldsymbol{\sigma^2}_{\text{income}} = \sigma^2_{\text{age}} + \sigma^2_{\text{sex}} + \sigma^2_{\text{tenure}} + \boldsymbol{\sigma^2}_{\text{qualification}} + \ldots$$

We acknowledge that this simple linear equation is not necessarily a good model for the relationship between income and the independent variables analysed. However, it serves for our purpose of providing a rough indication of the relevant importance of different determinants of income.

[1] Grömping, U (2006). "Relative Importance for Linear Regression in R: The Package relaimpo" in Journal of Statistical Software, vol 17 (1)

Variation analysis confirms that a large proportion of variation in earnings across industries cannot be explained by qualification, experience (both industry and non-industry) or gender. However, we can observe that experience has a relatively significant influence on income and that qualifications are less important than experience.

Variation analysis

Industry	% variation explained				
	Age	Sex	Industry tenure	Qualification	Residual
Dairy farming	1.33%	5.41%	5.89%	1.08%	86.29%
Beef & sheep farming	0.60%	5.60%	4.18%	0.66%	88.96%
Forestry	4.91%	0.28%	4.57%	2.35%	87.89%
Carpentry	9.86%	0.29%	7.83%	6.09%	75.93%
Electrical service	6.51%	3.13%	9.55%	3.28%	77.52%
Engineering	11.81%	5.59%	7.95%	6.90%	67.76%

Source: …\Checked\Denny\13-06-16\20160613 ROI.xls; …\Checked\Denny\15-07-16\20160714 ROI.xls

The LMG metric is calculated by averaging the percentage of variation explained by regressors over different permutation of regressors. For different permutations, the resulting percentage of variation explained by each regressor is different. See the paper by Grömping[1] for more details. In the table below, we show the upper and lower estimates of percentage of variation explained by each regressor, as a result of different permutations of regressors. This crudely represents a certainty range of the numbers presented in the previous slide. A better measure would be "bootstrap confidence interval" as described in the paper[1], but this is not currently possible under Statistics New Zealand's data laboratory environment.

Variation analysis - appendix

Industry	% variation explained			
	Age	Sex	Industry tenure	Qualification
Dairy farming	0.36% - 2.40%	4.82% - 5.95%	4.28% - 7.60%	0.44% - 1.69%
Beef & sheep farming	0.00% - 1.44%	4.65% - 6.53%	2.88% - 5.76%	0.14% - 1.10%
Forestry	2.64% - 7.53%	0.03% - 0.72%	2.29% - 7.06%	1.83% - 2.79%
Carpentry	5.83% - 13.97%	0.00% - 0.87%	3.57% - 12.04%	5.66% - 6.50%
Electrical service	2.35% - 11.59%	1.88% - 5.20%	5.42% - 13.64%	2.30% - 4.42%
Engineering	5.39% - 20.06%	3.87% - 7.55%	2.74% - 14.08%	3.79% - 10.45%

[1] Grömping, U (2006). "Relative Importance for Linear Regression in R: The Package relaimpo" in Journal of Statistical Software, vol 17 (1)