Mind the Gap: Earnings Effects from Greater Proficiency and Use of Core Skills: A New Zealand Perspective

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Abstract

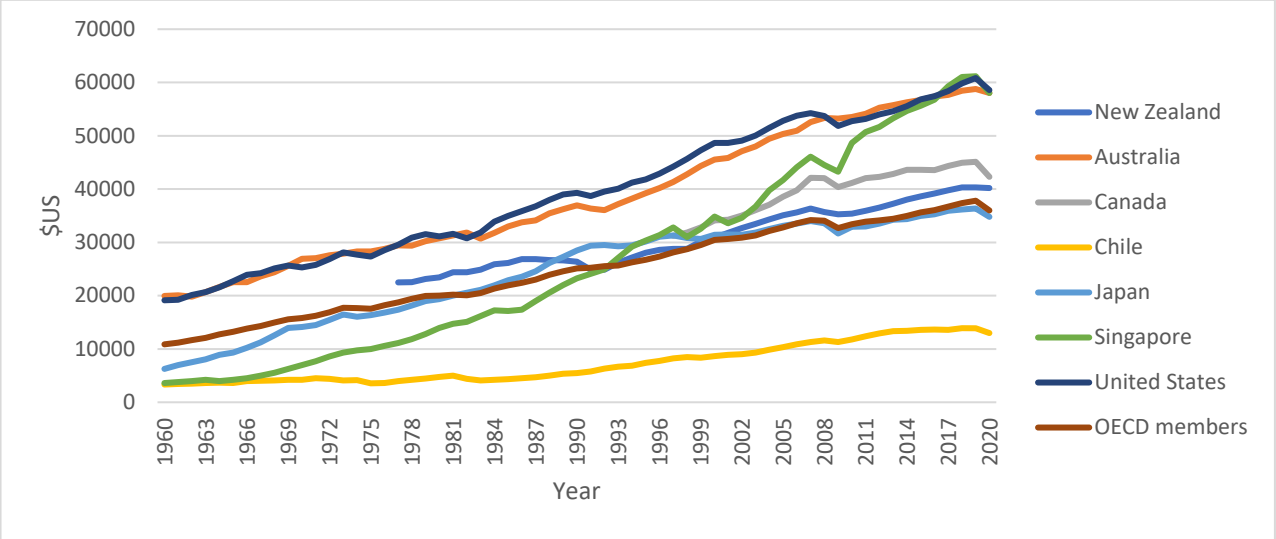
The need for the New Zealand economy to close the earnings gap with comparable developed economies has received increasing attention and scrutiny in recent times, with the importance of fundamentals skills in the workforce a key component in achieving this. This paper examines the effect for worker earnings of greater skill proficiency in literacy, numeracy and information and communications technology (ICT) problem-solving together with the use of these skills in the home and workplace. The analysis is based on data from the Organisation for Economic Cooperation and Development's Programme for the International Assessment of Adult Competencies (PIAAC) survey undertaken for New Zealand in the 2014 to 2015 period. Using cross-sectional analysis, the results show that while increased proficiency in each of these three core skills is found to improve worker earnings, the strongest positive effect is seen for ICT problem-solving skills and that greater use of this skill set in particular, in workplace tasks and activities will improve average earnings for the New Zealand worker. The results also emphasise the importance of continuing education and the traditional effects of qualifications for earnings. These findings further encourage policy for transitioning towards an ICT-based New Zealand work environment to support the labour market's demand for these activities, in turn raising average worker income.

1. Introduction

There has been a concern for many years that the New Zealand economy has continued to experience falling income and productivity levels, relative to other comparable economies. This has created an income gap, contributing to a fall in the relative standard of living. This gap can be seen in Figure 1 where, Against the New Zealand performance, Real GDP per capita in US dollars is higher for Australia, Singapore, the United States and Canada. New Zealand has however, maintained higher levels of Real

GDP per capita than the OECD average and Japan. Real GDP per capita levels are lower for the developing economy of Chile, but improving.

Figure 1. Real GDP per Capita Comparisons, 2015 US$. Selected Countries



Source: https://www.data.worldbank.org/indicator/NY.GDP

A key driver of longer-term income growth is productivity. As Paul Krugman (1997, p.11) famously noted, "Productivity isn't everything, but in the long run it is almost everything". Kidd (2008), in studying factors underlying New Zealand's productivity performance identified skill levels as a key driver. Supporting this, the 2015 report of the New Zealand Tertiary Education Commission considers that approximately 40 per cent of individuals in the New Zealand workforce do not have sufficient literacy and numeracy skills to function well in a knowledge society and information economy [1]. These factors provide the motivation for this paper in developing greater understanding of the potential for improving skill levels to lift New Zealand's productivity and income performance.

The traditional measures of skills, or human capital, of schooling or qualifications are well established in the literature, starting from the foundational work of Mincer (1974). The availability of recent data, principally through the OECD's Programme for

[1] The Tertiary Education Commission is a New Zealand Government Crown Agency with responsibility to lead the Government's relationship with the tertiary education sector and to provide career services from education to employment.

the International Assessment of Adult Competencies (PIAAC) survey of adult skills [2] allows for further narrowing down into the effects of the core educational skills of literacy and numeracy. These are skills essential for everyday productive life and a well-functioning workforce. This survey data also provides for study of the effects of proficiency and usage of problem-solving skills in information communication and technology (ICT) for average earnings. This rich data set will allow a comprehensive study of the impact of human capital factors in the New Zealand labour market on worker income. Average occupational skill level and demographic factors are also studied as important determinants for differences in income.

Using New Zealand population survey data for the 2014 to 2015 period, this study uses a novel approach to examining earnings effects for the core skills by employing a rate of change interpretation for earnings using continuous skill level variables. This approach diverges from the skills matching probability approach that is prevalent in the literature through the work of Adalet et al (2015), McGowan and Andrews (2015, 2017) and others.

For the main findings of this paper, I find that an increase in proficiency in the core skills of literacy, numeracy, and ICT problem-solving will improve earnings for New Zealand workers, with the largest positive effect from improved ICT problem-solving skills. Increases to numeracy skill proficiency has the second-largest positive effect, followed by literacy skills. Workplace tasks and practice that allow for greater use of the core skills are also positive for improving worker earnings. In particular, an increase in the frequency of use of ICT problem-solving in work tasks is significant for lifting worker income. My study also finds evidence for increased earnings from tasks involving greater use of numeracy and reading skills in the workplace. It would be expected that this increase in earnings does not automatically happen but reflects improvements to productivity and business growth that may come from a higher skilled workforce. These improvements in turn increase the derived demand for workers with higher ability in these core skills in the New Zealand labour market.

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[2] Source: https://www.oecd.org/skills/piaac/

The rich survey data available from the PIAAC programme allows the inclusion of the traditional measures of years of schooling and experience for this study of skill effects on earnings for the New Zealand economy. There is a positive and significant effect on earnings from these measures, consistent with the expectation from previous research. An important contributed result is the finding of improvements for individual earnings as a result of further adult education and job-related training. This reinforces the benefits from access to further education programmes beyond the foundation schooling system. This education needs to be related to occupations, however, to be of monetary value.

Average worker earnings are found to rise with increases to average industry skill level and occupational skill level. The results show an earnings differential by occupational skill level with the largest difference in earnings predicted between elementary skilled and skilled occupations. White collared workers see a larger earnings gap than do blue collared workers. This may allude to the 'hollowing out' effect of middle-range and white collar tasks as discussed by Levy and Murnane (2004) and others. There is argument for improving the skill and value for workers in each occupational skill category to improve earnings. The earnings gap for female workers is very much evident in this study. Females earn less than males on average and in each occupational category.

In examining the relationship between industry skill level and worker earnings, industries are grouped into broad skill categories using the ANZSCO skill classification methodology [3]. A rising skill and income trend is observed with the lowest earnings in the lower skilled industries of retail and hospitality. These two sectors are significant contributors to employment with a combined 17 per cent share. (Employment shares for New Zealand industries are set out as Appendix 1). Additionally, there is a greater representation of female workers in the lower skilled retail and hospitality sectors.

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[3] The Australian and New Zealand Standard Classification of Occupations (ANZSCO) is the product of a development program undertaken jointly by the Australian Bureau of Statistics, Statistics New Zealand and the Australian Government Department of Employment and Workplace Relations. The program sets out to classify all occupations and jobs in the Australian and New Zealand labour markets on the basis of required average skill level.

(Appendix 4 shows industry employment shares for each New Zealand industry by gender and employment status). Female workers also have greater part-time involvement in each of the industries studied. These findings indicate the need for policy to help lift earnings for workers particularly in these lower skilled occupations and particularly of female workers. This will be important in raising the earnings and standard of living for individuals, their households, and for the overall economy.

In studying earnings differences by age category, the familiar U-shaped earnings profile experienced in other labour markets occurs (Thornton, Rodgers and Brookshire, 1997), as the importance of worker experience begins to taper off, but a surprise effect is observed for peak earnings. This study contributes further to the literature in showing that these occur for those in the 35 to 44-year age group rather than the 45 to 55-year indicate a loss of potential earnings through a possible devaluing of both younger and older workers. It may also point to possible age discrimination in the New Zealand workforce. The earnings gap for female workers is again evident with female workers experiencing lower average earnings for each age category. The results show the need to lift overall skill levels and improve the value of certain skills for raising earnings, particularly female workers' earnings, in order to close New Zealand's income gap.

2. Related Literature

The literature underscores the importance of human capital factors for lifting earnings and productivity levels. Early research into the positive impact of these factors for income is found in the descriptive statistical work of Denison (1962) in calculating the contribution of years of schooling, as a measure of the quality of the labour force, to the growth rate of U.S. national income. Chiswick and Mincer (1972) established the econometric framework for studying human capital effects on earnings in a relatively simple model measuring the impacts of years of schooling and age for worker income. Mincer's (1974) prominent work further developed the key human capital-earnings econometric model through the inclusion of years of work experience and post-school investments in human capital in establishing individual earnings as the common dependent measure for schooling effects. In contrast to earlier work, Mincer demonstrated that years of work experience, rather than age, is the more important factor for earnings. Other measures that have variously been used to measure human capital

and skills include occupational skill level (Carbonaro, (2006), labour compensation (Oxley, Le and Gibson, 2008), and cross-classification of measures by sex, age, and employment status (Jorgenson, Gollop and Fraumeni, 1987).

While schooling and experience variables will be used in this study as important measures of human capital, there are some limitations in their use. Card (2000) notes that education tends to be a "one-time" thing, essentially unchanging after a worker reaches twenty-five. Many workers, though, do receive additional training for their existing jobs and for new jobs, sometimes without changing employers. Bartel (1995) and Lowenstein and Spletzer (1996) argue that much of the increase in wages associated with job tenure may be attributable to employer-provided training, which is unmeasured by years of formal education. Both findings suggest that a multidimensional view of skills might be useful in understanding earnings patterns, a consideration which this study will recognise in the inclusion of further job-training explanatory variables.

In understanding the impact of schooling and qualifications for earnings, it is important to drill down further for the skills that are most demanded by firms and to determine if there are mismatches occurring in the labour market. Much research work has examined the effects for earnings of the education levels expected or required for occupations and those provided by workers and whether there are under or over-education effects occurring. Earlier work in this area includes that of Duncan and Hoffman (1981). Using panel income data for the U.S. workforce they find that nearly 40 per cent of workers have more education than their jobs require but also that 'surplus' education does have economic value.

More recent studies such as that of Pellizzari and Fichen (2013) have made use of the Organisation for Economic Co-operation and Development (OECD)'s Programme for the International Assessment of Adult Competencies (PIAAC) survey data. This is the data on which this study will draw. Pellizzari and Fichen (2013) include the skill domains of literacy and numeracy as measures of skills mismatch. They find overlap between the measures is substantial where 94 per cent of workers who are well-matched in literacy are also well-matched in numeracy. The authors contend that a better match of workers' skills to the requirements of their jobs can reduce the waste of skills among the over-skilled and improve the efficiency of the under-skilled at the same time. The

expectation is that this should lead to important improvements in the overall productivity of the economy and lift the well-being of individuals. Little evidence is found in the existing literature for the effects of changes in the proficiency and use of the core skills of literacy and numeracy for earnings. This serves as motivation in this study in addressing this key gap in the literature, particularly as it pertains to the New Zealand earnings gap that is a central issue for this research.

The literature also highlights the key role that technology plays for lifting income and productivity in both its complementary and substitution relationships with human capital. The theory of skill-biased technical change centres around the expectation that changes in technology have caused increased demand for workers with higher skills at the expense of those with lower skills, contributing to wage inequality and labour employment effects. Acemoglu and Autor (2011) refer to this as the canonical model, where the labour force is considered to comprise of two distinct skill level groups, or occupations, performing imperfectly substitutable tasks. Technology is assumed to take a factor-augmenting form, complementing either high or low skilled workers to generate skill-biased demand shifts. The impact of technology and its effects on skills for earnings in the New Zealand economy will form an important component of this study.

3. Hypotheses and Rationales

The existing literature shows a positive relationship between years of schooling and qualifications, as the traditional measures of human capital, and earnings. Yet these are relatively broad measures with no identification of the skills that underlie schooling progress. These skills include core achievement in literacy and numeracy skills. Additionally, in an era of progress digital technology, the broader schooling variables do not recognise the contribution to worker productivity and earnings potential from ability in the use of technology. Recent data has allowed for the inclusion of these core skills of literacy, numeracy, and also ability in the use of information communication technology (ICT) in the course of performing workplace tasks. The latter largely involves the ability to use and solve problems workplace computer equipment. These are core skills that underly basic worker competency which makes it important to understand the effects of demand for proficiency and use of these skills for potential

worker earnings. This need coupled with the availability of the rich PIAAC data set provides the rationale for the main hypothesis of this study:

Hypothesis One: Increases in proficiency and in the frequency of use of the core skills of literacy, numeracy, and ICT problem-solving will increase average hourly earnings in the New Zealand labour market.

This main hypothesis will be broken into two sub-hypothesis due to collinearity issues in combined testing:

Sub-hypothesis One: An increase in proficiency in the core skills of literacy, numeracy and ICT problem-solving will increase average hourly earnings in the New Zealand labour market.

Sub-hypothesis Two: An increase in the frequency of use of the core skills of literacy, numeracy and ICT-problem solving will increase average hourly earnings in the New Zealand labour market.

This study will seek to examine the impact of industry skill for income in two ways: First, by broad occupational skill impacts for worker earnings, and secondly, in a statistical setting, by examining the effects of skill for average earnings attributable to the individual industry sectors individuals are employed in. In a U.S. study, Carbonaro (2006) finds that occupational sorting accounts for over half of the difference in worker earnings. Levy and Murnane (2004) find a 'hollowing out' effect for those in the middle skilled occupations. It will be important to test these findings for the New Zealand labour market. This research will contribute to the literature in so doing. The two skill dimensions of occupational and individual industry effects for worker income will be examined in the following two hypotheses:

Hypothesis Two: An increase in average occupational skill level will increase average hourly earnings in the New Zealand labour market.

Hypothesis Three: Individual earnings will rise with increases to average industry skill level in the New Zealand labour market.

The effects on earnings of two additional factors are examined in this paper: those of age and gender. Although focused primarily on the effects of skills, for a study on factors affecting income it is essential to understand the effect that age and gender may have for income levels. For age effects, the work of Mincer (1974) and Thornton, Rodgers and Brookshire (1997) show the typical U-shaped age-earnings profile with peak earnings occurring for the 50 and above age groups. This reflects the impact of key factors including years of work experience and seniority on earnings. Conversely, Murphy and Welch (1990) contend that this profile may not be as clearly defined as often depicted where differences in human capital effects such as qualifications attained or quality of schooling between generational groups may affect the age-earnings profile. This consideration motivates this study for examining the current earnings profiles in the New Zealand labour market and implications that may arise from the findings.

It is widely reported in international governmental labour force data and the literature of the gap in earnings of female workers relative to males. In their study of gender lifetime earnings for the German workforce, Boll, Jahn and Lagemann (2017) find that for individuals born in the period 1950 to 1964, at the end of their employment career, women accumulate average earnings that are 49.8 per cent lower than for men. This gender lifetime gap is more than twice as high as the German gender pay gap at the time of the study in 2017. This study will contribute to the literature in examining impacts of the two key factors of age and gender on worker earnings. The effects are tested in the following two hypothesis:

Hypothesis Four: Individual earnings will rise with increases to age in the New Zealand labour market.

Hypothesis Five: Male workers earn higher wages than female workers in the New Zealand labour market.

4. Data and Methodology

4.1 Data and Variables

The data used for this analysis is the skill and occupation data developed from the first cycle of the OECD's Programme for the International Assessment of Adult

Competencies (PIAAC) [3]. This programme involved a comprehensive questionnaire survey completed for a representative sample of each participating country's population. The survey measures adult proficiency in the key information-processing skills of literacy, numeracy and ICT problem-solving, gathering data and information on how adults use these skills at home, at work, and in the wider community. New Zealand was included in the second round of countries which took place in the 2014 to 2015 period, for the first cycle of the survey programme. 6,176 New Zealanders were surveyed and asked a wide range of questions on subjects including their use of literacy, numeracy and ICT skills, further skill and occupation-related questions, and demographic information.

In order to test the main hypothesis that greater core skill proficiency and use will increase earnings, the following variables are included in regression equations:

The dependent variable is average hourly earnings *learnhr*. This variable is used in logarithmic form to provide for percentage change interpretations for the effect of the explanatory variables on earnings (Wooldridge, 2013). The core explanatory skill variables include measures for proficiency in literacy, numeracy and problem-solving using ICT, in logarithmic form:

- average literacy proficiency *lavelitprof*
- average numeracy proficiency *lavgnumprof*
- average problem solving with ICT proficiency *lavgprobslvictprof*

The ICT proficiency variable is developed from a survey question asking for opinion on the respondent's ICT proficiency for their work tasks. Variables are developed for frequency of use of the core skills at home and at work, again in logarithmic form to allow for percentage change interpretations:

- reading at home *lreadhome*
- reading at work *lreadwork*
- writing at home *lwritehome*

[3] The first cycle of this international survey was conducted for 36 participating countries over three rounds with the intention to measure the key cognitive and workplace skills needed for individuals to participate in society and for economies to prosper. www.oecd.org/skills/piaac.

- use of numeracy at work *lnumwork*
- use of ICT at home *licthome*
- use of ICT at work *lictwork*

Occupational skill variables are employed to understand differences in earnings by broad occupational skill groups. These are:

- elementary occupations *elementocc,*
- semi-skilled blue collared occupations *semiskillbluecoll,*
- semi-skilled white collared occupations *semiskillwhitecoll,*
- skilled occupations *skilledocc*

Control variables and further variables of interest in X in regression equation (1) below include:

- qualifications imputed into years *yrsqual*
- years of work experience *yrswrkexp* and a quadratic version $yrswrkexp^2$ to capture non-linear effects.
- formal and informal adult education and training in the last twelve months that is job-related *fnfaet12jr*
- a variable *llearnatwork* for whether an individual is provided with training at work, and a variable measuring an individual's readiness to work *lreadytolearn*, both in logarithmic form.
- language variables to understand any communication effects for earnings in the New Zealand workforce:

    - English as the individual's native language *engnativelang*
    - bilingual including English *bilingualwitheng*
    - English is the language most commonly spoken in the home *homelangeng*

- a variable to capture gender effects, *female,* using males as the base group.

4.2 Models and Methodology

This study will estimate a number of wage regressions to test the hypotheses set out above. The basic regression equation takes the following form:

$$\ln(w)_i = \alpha + \beta 1 CS_i + \beta 2 X_i + \beta 3 Z + \mu_i \quad (1)$$

where

$\ln(w)_i$ is the logarithim of average hourly wages

CS_i includes the variables for proficiency and frequency of use of the core skills of literacy, numeracy and ICT problem-solving, in logarithmic form

X_i is a vector of control variables

Z_i is a vector of further variables of interest

μ_i is the error term.

The modelling methodology employed in this study is cross-sectional regression. Cross-sectional modelling is used as the survey provides data for one time period. A second cycle of the survey is planned for the 2022 – 2024 period for which New Zealand is a participating country [4]. This will allow for future panel data modelling of skill effects. Stata is used as the modelling software.

4.3 Tests for Robustness

Measures undertaken to improve the robustness of the results include model variation tests with equations incorporating different combinations of variables of interest and control variables. This has allowed examination of the consistency of results for the same variable in different equation combinations. Alternative base groups were used in the category variable regressions to test for variation in results. These have provided similar regression results.

The Breusch-Pagan / Cook-Weisberg and Cameron & Trivedi's decomposition tests were undertaken which indicated a presence of heteroskedasticity in some of the modelling work undertaken. To correct for this, models presented use robust standard errors which produce lower overall standard errors. Variance inflation factor (VIF) tests

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[4] Because of the Covid pandemic, the data collection for the 2nd cycle of the survey will take place in the 2022-2024 period with the results to be published in 2024.
https://www.oecd.org/skills/piaac/about/piaac2ndcycle/.

were undertaken to test for multi-collinearity between variables. For most of the modelling the test results recorded VIF scores less than 2.0. This study utilises the approach taken by Green et al, 2017 and others that a score of 1 indicates no correlation and between 1 and 5 indicates some to moderate correlation. VIF scores above 10 indicate high correlation and accordingly models with such higher average scores were rejected.

5. Empirical Results

This section presents empirical results. The results show the effects of the core skills, average occupational skills, gender and age on average earnings growth for the representative sample of New Zealanders surveyed. These are discussed in detail below.

5.1. The Effects of Proficiency in the Core Skills on Average Hourly Earnings

This section will test sub-hypothesis one, that an increase in proficiency in the core skills of literacy, numeracy and ICT problem-solving will increase average hourly earnings. Modelling for these skills involved consideration of the degree of correlation that may exist between them. ICT problem-solving, for example, will require an existing level of proficiency in the core skills of literacy and numeracy. When combined in one regression, variance inflation factor (VIF) tests for collinearity for the three skills approached 10, indicating moderate to strong collinearity between the skills. Including just the literacy and numeracy variables together produced VIF scores of 5 to 6. Based on these results, two separate regressions were run as shown in Table 1. Column 1 shows literacy and numeracy proficiency skill effects on average hourly earnings, and Column 2 presents ICT problem-solving effects separately [5].

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[5] Additionally, when the three skill proficiency variables are included in the same regression, the co-efficient on the ICT problem-solving variable (*lavgprobslvictprof*) displays a negative sign. This goes against the intuition or expectation of the effects of problem-solving skills for earnings. This variable is then regressed on the other skill proficiency variables and also the frequency of skill use variables. The residual was then used for the ICT problem-solving variable in the original regression. Similar results to those for the original ICT problem-solving variable were obtained. The skills proficiency variables were also standardised. This approach again yielded similar results.

The results support the hypothesis that an increase in skill proficiency will increase average hourly earnings, with positive earnings effects observed for each of the core skills. Variables in logs will be interpreted as the effect of a 10 per cent increase in their frequency or attainment level. The largest effect is seen for increased proficiency in ICT-problem solving skills (*lavgprobslvictprof)* in Column 2. An improvement in proficiency in ICT skills increases average hourly earnings by 5.1 per cent, at the 1 per cent significance level. Column 1 shows that numeracy skills (*lavgnumprof)* has the second-largest effect where an increase in this skill increases average earnings by 4.1 per cent. Greater literacy proficiency (*lavglitprof)* increases earnings by 2.5 per cent, at the 5 per cent significance level.

The control variables qualifications (*yrsqual),* as measured in years of schooling, and years of work experience (*yrswrkexp)* show positive and statistically significant effects, consistent with the findings of Mincer (1974) and Barro and Lee (1996). Column 1 shows that an additional year of schooling *yrsqual* increases average hourly earnings by 4.8 per cent and by 2.4 per cent for a year of work experience *yrswrkexp*, both at the 1 per cent significance level. While important, work experience has half the quantitative effect for average earnings that an additional year of education does.

Now, turn to the results for further variables of interest. I find a positive relationship between job-related formal and informal adult education and training in the last 12 months (*fnfaet12jr)* and real average hourly earnings in the New Zealand workforce. Column 1 shows a 6.2 per cent increase in average earnings in Equation 1 and a 7 per cent increase in Column 2. This indicates the importance of continuing education for furthering an individual's earnings potential. These findings are consistent with those of Bartel (1995) and Lowenstein and Spletzer (1996). A variable to indicate a person's readiness to learn (*lreadytolearn)* is included, but no statistically or economically significant result is observed. This may be expected as simply being ready to learn is not likely to generate additional worker earnings in of itself. The variable workplace training (*llearnatwork)* shows some significance for earnings, where an increase in on-the-job training increases earnings by 0.4 per cent at the 1 per cent significance level in Column 1 and in Column 3, when further variables are added. This

reduces to 0.3 percent in Columns 2 and 4 at the 5 per cent significance level in regressions with the ICT skill proficiency variable.

Variables are added to measure language effects for earnings in the New Zealand labour market. This is principally to assess whether the use of the common language of English is important for earnings and also whether language effects may affect the core skill results. The results are shown in Columns 3 and 4 in Table 1. The variables are English as a person's native language (*engnativelang),* bilingual with English (*bilingualwitheng),* and if English is the main language spoken in the individual's home *(homelangeng).* Only being bilingual with English has significant effects for earnings, and here the effect is negative. The ability to speak English would generally be considered positive in the New Zealand labour market. However, the results show no discernible impact on worker's income. Additionally, it appears that ability in the use of more than one language is not a skill that will tend to increase earnings. There is also only a small decrease in literacy proficiency earnings effects observed when language variables are included, with no verification of causation.

A variable is also included to estimate gender effects (*female*) with males as the base group. Average female earnings are less than males in the range of 14 to 16 per cent across the columns. This shows significant difference in earnings by gender in the New Zealand workforce.

Table 1. Proficiency in Core Skills Effects for Average Hourly Earnings in the New Zealand Labour Market. Dependent variable: Log Average Hourly Earnings

	Literacy and Numeracy Proficiency Effects for Average Hourly Earnings (1)	ICT Problem-Solving Proficiency Effects for Average Hourly Earnings (2)	Literacy and Numeracy Proficiency Effects for Earnings Including Language Effects (3)	ICT Problem-Solving Proficiency Effects for Earnings Including Language Effects (4)
lavglitprof	0.252**	-	0.231**	
	(0.102)		(0.104)	
lavgnumprof	0.408***	-	0.404***	
	(0.091)		(0.091)	
lavgprobslvictprof	-	0.507***	-	0.507***
		(0.052)		(0.052)
yrsqual	0.048***	0.058***	0.50***	0.058***
	(0.003)	(0.003)	(0.003)	(0.003)
yrswrkexp	0.024***	0.027***	0.024***	0.027***
	(0.002)	(0.002)	(0.002)	(0.002)
$yrswrkexp^2$	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
fnfaet12jr	0.062***	0.070***	0.062***	0.070***
	(0.015)	(0.016)	(0.015)	(0.016)
lreadytolearn	0.008	0.015	0.009	0.015
	(0.014)	(0.015)	(0.014)	(0.015)
llearnatwork	0.037***	0.029**	0.037***	0.029**
	(0.013)	(0.014)	(0.013)	(0.014)
engnatlang			-0.007	0.020
			(0.027)	(0.027)
bilingeng			-0.058*	-0.099***
			(0.030)	(0.029)
homelangeng			0.046	0.034
			(0.029)	(0.030)
female	-0.138***	-0.160***	-0.138***	-0.160***
	(0.014)	(0.014)	(0.014)	(0.014)
cons	-1.52***	-0.882***	-1.42***	-0.882***
	(0.471)	(0.275)	(0.254)	(0.275)
Number of obs.	3,071	2,870	3,071	2,870
R-squared	0.32	0.31	0.33	0.31
Mean VIF	5.37	3.72	4.46	3.72

Notes: Dependent variable is average hourly earnings; *lavglitprof* is average literacy proficiency; *lavgnumprof* is average numeracy proficiency; *lavgprobslvictprof* is average ICT problem-solving proficiency; *yrsqual* is years of schooling; *yrswrkexp* is years of work experience; $yrswrkexp^2$ is a quadratic for years of work experience; *fnfaet12jr* is job-related formal and informal adult education and training in the last 12 months; *lreadytolearn* measures an individual's readiness to work; *llearnatwork* indicates workplace training; *engnatlang* is English as the individual's native language; *bilingeng* is bilingual with English; *homelangeng* indicates English is the language most commonly spoken in the home; *female* is a gender variable. Robust standard errors in parenthesis. Statistical significance: *** at the 1% level, ** 5% level, * 10% level.

5.2. The Effects of Usage of the Core Skills on Average Hourly Earnings

This section will test the second important sub-hypothesis, that an increase in the frequency of use of the core skills of literacy, numeracy and ICT-problem solving will increase average hourly earnings in the New Zealand workforce. The examination of the effects of these variables for earnings is relatively new research, with a greater focus on the existing literature, particularly on using PIAAC data, under topics including the effect of skills mismatch for earnings. This latter research includes important works by McGowan and Andrews (2015), and Yeo and Maani (2017) for the New Zealand labour market. I examine the use of these core skills in the home and workplace and the results, together with control variables, are shown in Table 2. Column 1 presents the results on earnings for the frequency of skill use variables alone. Column 2 includes control variables. Column 3 adds the three proficiency variables to the results, and Column 4 includes language effects. The degree of skill proficiency is likely to influence the use of the core skills. I have included skill proficiency variables in Column 3 to evaluate where proficiency may impact on earnings from skill usage. VIF collinearity scores for the three skill proficiency measures reduce from the Table 1 results, so the addition of the frequency of use variables allow the inclusion of all three measures in the same regression in Columns 3 and 4 (however, a negative sign is still observed for the ICT problem-solving proficiency variable (*lavgprobslvictprof)*.

The results provide partial support for the hypothesis, where an increase in the use of ICT problem-solving skills in the workplace (*lictwork)* in particular, increases average hourly earnings in each of the regression results presented. Again, variables in logs are interpreted as the effect on average earnings from a 10 per cent increase to these variables. An increase to the frequency of use of ICT problem-solving skills improves average hourly earnings by 14 per cent, in Column 1, with no control variables added. This reduces to 0.7 to 0.9 per cent when control variables are added in Columns 2 to 4. The results are all significant at the 1 per cent level. Workplace tasks that involve reading (*lreadwork)* also lift workers' earnings for three of the regression: by 2.1 per cent in column 1, with no control variables, and by 10 per cent in Columns 3 and 4, where skill proficiency and language variables are added. For numeracy (*lnumwork*), increased usage in the workplace increases average hourly earnings by 0.4 per cent at

the 1 per cent significance level in Column 2 alone, when control variables are added. The effects are generally more pronounced for work usage of these skills than for home use. The insignificant results for home use (apart from reading at home (*lreadhome)*, with an unexpected negative sign) are expected, as individuals are generally paid for their use of the skills in the workplace without recognition of use in the home. In this regard, those surveyed are asked to make a clear distinction between workplace and home usage of the core skills.

There are similar findings for the skill proficiency variables shown in Columns 3 and 4 of Table 2 as for the findings in Table 1. I find that numeracy proficiency (*lavgnumprof)* increases average hourly earnings by a range of 4.4 to 6.1 per cent. Literacy skill proficiency increases average earnings between 3.3 to 4.2 per cent, respectively. ICT problem-solving proficiency *(lavgprobslvictprof)* is included in this regression as the VIF multi-collinearity scores are lower with the additional skill use variables included. However, the coefficient is negative which is against intuition or expectation for earnings effects from problem-solving skills. This may indicate a confounding variable effect when ICT is included with literacy and proficiency variables. Beyond a certain level of proficiency, it may be that it is usage of ICT, rather than proficiency, that has the most significant impact for the value placed on workers, reflected in their earnings. An individual will also need a certain level of core literacy and numeracy skill to allow for proficiency and usage of ICT. Considering the control variables, similar results are found for years of schooling (*yrsqual)* and years of experience (*yrswrkexp)* as for the regression results shown in Table 1. In contrast, learning at work (*llearnatwork)*, though positive, is not statistically significant.

Table 2. Frequency of Use of the Core Skills Effects for Average Hourly Earnings in the New Zealand Labour Market. Dependent variable: Log Average Hourly Earnings

	Frequency of Skill Use (1)	Frequency of Skill Use with Control Variables (2)	Frequency of Skill Use including Proficiency Scales (3)	Including Language Effects (4)
lreadhome	-0.085**	-0.162***	-0.169***	-0.168***
	(0.042)	(0.041)	(0.039)	(0.041)
lreadwork	0.209***	0.042	0.101**	0.100**
	90.035)	(0.039)	(0.040)	(0.039)
lwritehome	-0.030	-0.012	-0.008	-0.011
	(0.029)	(0.027)	(0.026)	(0.028)
lwritework	0.074***	0.026	0.028	0.029
	(0.020)	(0.023)	(0.024)	(0.023)
lnumhome	0.037*	0.031	0.007	0.009
	(0.020)	(0.023)	(0.023)	(0.020)
lnumwork	0.020	0.039***	0.018	0.018
	(0.015)	(0.015)	(0.015)	(0.017)
licthome	-0.013	0.021	0.007	0.013
	(0.025)	(0.025)	(0.025)	(0.027)
lictwork	0.139***	0.087***	0.069***	0.072***
	(0.019)	(0.018)	(0.019)	(0.020)
yrsqual		0.062***	0.047***	0.048***
		(0.004)	(0.004)	(0.004)
yrswrkexp		0.030***	0.025***	0.025***
		(0.002)	(0.003)	(0.003)
$yrswrkexp^2$		-0.000***	-0.000***	-0.000***
		(0.000)	(0.000)	(0.000)
fnfaet12jr		0.061***	0.043**	0.044**
		(0.022)	(0.022)	(0.021)
lreadytolearn		0.002	-0.009	-0.005
		(0.015)	(0.021)	(0.023)
llearnatwork		-0.016	0.018	0.016
		(0.021)	(0.021)	(0.020)
engnatlang				0.031
				(0.034)
bilingeng				-0.079*
				(0.042)
homelangeng				0.007
				(0.039)
female		-0.152***	-0.126***	-0.127***
		(0.018)	(0.018)	(0.018)
lavglitprof			0.423***	0.330*
			(0.133)	(0.018)
lavgnumprof			0.437***	0.612***
			(0.102)	(0.143)
lavgprobslvictprof			-0.202**	-0.318**
			(0.097)	(0.129)
cons		2.02***	1.55***	-1.297***
		(0.061)	(0.425)	(0.447)
Number of obs.	2,111	1,925	1,889	1,889
R-squared	0.11	0.30	0.34	0.34
Mean VIF	1.45	3.23	3.79	3.50

Notes: Dependent variable is average hourly earnings; variables included for frequency of use of core skills, in the home and workplace, together with skill proficiency variables*; yrsqual* is years of schooling; *yrswrkexp* is years of work experience, plus a quadratic: $yrswrkexp^2$*; fnfaet12jr* is job-related formal and informal adult education and training in last 12 months; *lreadytolearn* measures individual's readiness to work; *llearnatwork* indicates workplace training; *engnatlang* is English as the individual's native language; *bilingeng* is bilingual with English; *homelangeng* indicates English is the language most commonly spoken in the home; *female* is a gender variable. Robust standard errors in parenthesis. Statistical significance: *** at the 1% level, ** 5% level, * 10% level.

5.3.The Effects of Occupational Skill Level for Average Hourly Earnings

To examine broader skill level effects for earnings, this section tests hypothesis two, that an increase in occupational skill level will increase average hourly earnings in the New Zealand workforce. Previous studies find support for a positive relationship between occupational skill and earnings. Carbonaro (2006) finds, using data from the U.S. National Adult Literacy Study, that while less than half of the education and skill effects on earnings are reflected in occupational sorting, they remain positively related to earnings among workers within narrowly defined occupations. A greater earnings value is placed on the cognitive skills of workers employed in the more skill intensive occupations. Such a result makes it important also to control for other factors that influence earnings, which this research will do. This study will contribute to the literature in finding differences in the expected impacts of occupational skill categories for earnings.

From the OECD PIAAC survey, I include four occupation/skill categories. These are: elementary skilled occupations (*elementaryocc)*, semi-skilled blue collar occupations (*semiskillbluecoll)*, semi-skilled white collar occupations *(semiskillwhitecoll)*, and skilled occupations. Skilled occupations are used as the base category. Elementary skilled occupations were used as the base group but resulted in multicollinearity effects that were judged as too high using variance inflation factor (VIF) test score results. Control variables included are years of schooling (*yrsqual)*, total years of work experience (*totyrswrkexp),* and job-related formal and informal adult education and training (*fnfaet12jr).* Column 1 in Table 3 shows the results for occupation skill groupings.

The results presented in Column 1 support the hypothesis that an increase in occupational skill level will increase average hourly earnings. The three skill categories of elementary, blue collar and white collar occupations earn average hourly wage rates that are less than that of the base group of skilled workers in the New Zealand workforce. This is consistent with expected earnings differences between occupational skill levels. The results are statistically significant at the 1 per cent level. As is expected, the largest difference in earnings occurs between elementary skilled and skilled occupations where

elementary skilled workers (*elementaryocc)* earn average wages that are 37 percent lower than those in skilled categories.

A surprising result is that there is no uniform gradient effect between the occupational skill levels. The smallest wage differential with skilled occupations is found for semi-skilled blue collar workers (*semiskillbluecoll)*. This occupation group earn average hourly wage rates that are 21 per cent lower than skilled workers. In comparison, semi-skilled white collar workers (*semiskillwhitecoll)* earn average hourly wages that are 31 per cent lower than skilled workers. This may indicate the influence for income of factors other than skill level. This may include conditions payments for blue collar workers, whose occupations are typically in industry with a greater level of work environment considerations. Such industries include manufacturing, construction and the transport and storage sectors. The lower relative wages for white collared workers may also point to the possibility of an 'hollowing out' effect occurring in the New Zealand work force. This is the trend discussed by Levy and Murnane (2004) and Guo (2022) of the loss to automation of substitutable and 'middle-range' tasks typically found in white-collared positions such as clerical work and data-processing. The results suggest a lower value being placed on white collared workers, in turn constraining their income. The findings also indicate the potential to raise income for workers across the occupational skill groupings, relative to skilled workers, and particularly for the elementary skilled occupations, through improving skill levels.

The results in Tables 1 and 2 have shown a significant effect of gender on earnings which leads to a need to examine gender and skill level effects for earnings in this study. Column 2, Table 3 yields the results of occupational skill level interacted with gender, with males in skilled occupations used as the base category. Each of the gender/occupation categories earn less than the base group of skilled male workers, and each at the 1 percent significance level. The earnings differentials are more pronounced for females compared to males in each of the occupational skill groups. Female elementary occupation workers (*femelementaryocc)* earn average hourly wage rates that are 0.4 per cent less than males in elementary skilled roles (*maleelementaryocc)*. Females in blue collared occupations (*femalesemiskillbluecoll)* earn average wage rates that are 21 per cent less than blue collar male workers (*malesemiskillbluecoll)*, and white

collar female workers (*femalesemiskillwhitecoll)* earn 8 per cent less per hour on average than male white collar workers (*malesemiskillwhitecol)l*. Female skilled occupation workers *femaleskilledocc* earn 17 per cent less per hour than male skilled workers.

These results show the significant disadvantage for female workers compared to males in the New Zealand workforce relative to male skilled workers and when compared to males in similar occupational skill level groupings. More positively, they also show the significant potential gains to income for both females and households from policy designed to lift female earnings. Additionally, the consistent gains to worker earnings identified in previous regressions from further adult education and training is also observed, with a 6 per cent improvement to average hourly earnings. This highlights the positive earnings effects that may result from policy aimed at increasing adult training opportunities, particularly where these are job related.

Table 3. Occupational Skill Level Effects, including Gender Effects, on Average Hourly Earnings. Dependent variable: Log Average Hourly Earnings

	Occupational Skill Level Effects on Average Hourly Earnings (1)	Occupational Skill Level Effects on Average Hourly Earnings by Gender (2)
elementaryocc	-0.367***	
	(0.030)	
semiskillbluecoll	-0.214***	
	(0.019)	
semiskillwhitecoll	-0.309***	
	(0.016)	
maleelementaryocc		-0.462***
		(0.045)
malesemiskillbluecoll		-0.273***
		(0.022)
malesemiskillwhitecoll		-0.345***
		(0.028)
femelementaryocc		-0.466***
		(0.039)
femalesemiskillbluecoll		-0.482***
		(0.034)
femalesemiskillwhitecoll		-0.424***
		(0.021)
femaleskilledocc		-0.174***
		(0.021)
yrsqual	0.043***	0.044***
	(0.003)	(0.003)
yrswrkexp	0.022***	0.023***
	(0.002)	(0.002)
$yrswrkexp^2$	-0.000***	-0.000***
	(0.000)	(0.000)
fnfaet12jr	0.058***	0.057***
	(0.015)	(0.015)
cons	2.39	2.47
	(0.052)	(0.052)
Number of observations	3,139	3,139
R-squared	0.32	0.35

Notes: Dependent variable is average hourly earnings. For the average occupation skill levels for Column 1: *elementaryocc* is elementary occupations; *semiskillbluecoll* is semi-skilled blue collar occupations; *semiskillwhitecoll* is semi-skilled white collar occupations; skilled occupations is the base group. Each average occupation skill level is interacted with gender in Column 2, skilled male occupations is the base group. For the variables of interest and control variables: *yrsqual* is years of schooling; *yrswrkexp* is years of work experience; $yrswrkexp^2$ is quadratic years of work experience; *fnfaet12jr* is job-related formal and informal adult education and training in the last 12 months. Robust standard errors are shown in parenthesis. Statistical significance: *** at the 1% level, ** 5% level, * 10% level.

5.4. Industry Earning Differences Grouped by Average Skill Level

Continuing to examine the effects of occupational skill level for earnings, this section examines the effects for average hourly earnings for individual industries when grouped by average skill level. This work will test hypothesis three, that individual earnings will rise with increases to average industry skill level in the New Zealand labour market.

Table 4 shows differences in earnings for New Zealand industry compared with the retail and wholesale trade sectors, used as the base group. This sector grouping was chosen as the base group because it has the largest number of observations in the survey, at 605 (as detailed in Appendix 3), provides the lowest and most stable multi-collinearity results, and allows earnings comparisons to lower skilled sectors. Industries are grouped by average skill level as determined by the Australia New Zealand Standard Classification of Occupations (ANZSCO) and then into four broad skill categories. The categories are lower skilled, lower to medium skilled, medium to higher skilled, and higher skilled industries. The effects of years of schooling (*yrsqual*) and experience (*total years of work experience*) are controlled for in the regressions. The results show that, although there is variation for some sectors, there is evidence of support for the hypothesis. Average hourly earnings rise as overall industry skill level increases, relative to the lower skilled retail and wholesale trade sectors base group. Figure 2 shows this result in graphical form. The average lower skilled mining sector is a notable exception to the trend, with higher worker earnings likely due to conditions payments in this industry. The only industry with statistically significant lower average earnings relative to the retail sector is the similarly lower skilled accommodation and food services sector (*hospitality*).

For the lower to medium skilled industries, average hourly earnings are 15 per cent higher in manufacturing compared to retail, and in real estate, wage rates are 20 per cent higher. For the medium skilled industries, public administration, defence and social services average hourly earnings are 30 per cent higher. Information and communication and the financial and insurance services are 25 and 44 per cent higher than the lower skilled retail sector, respectively. For the higher skilled industries, earnings are higher in the professional, scientific and technical services industries, as expected, with a 24 per cent earnings difference. Interestingly the education sector

shows only a 4 per cent earnings difference to the retail sector. This may perhaps reflect the public service nature of education together with the large size of this workforce.

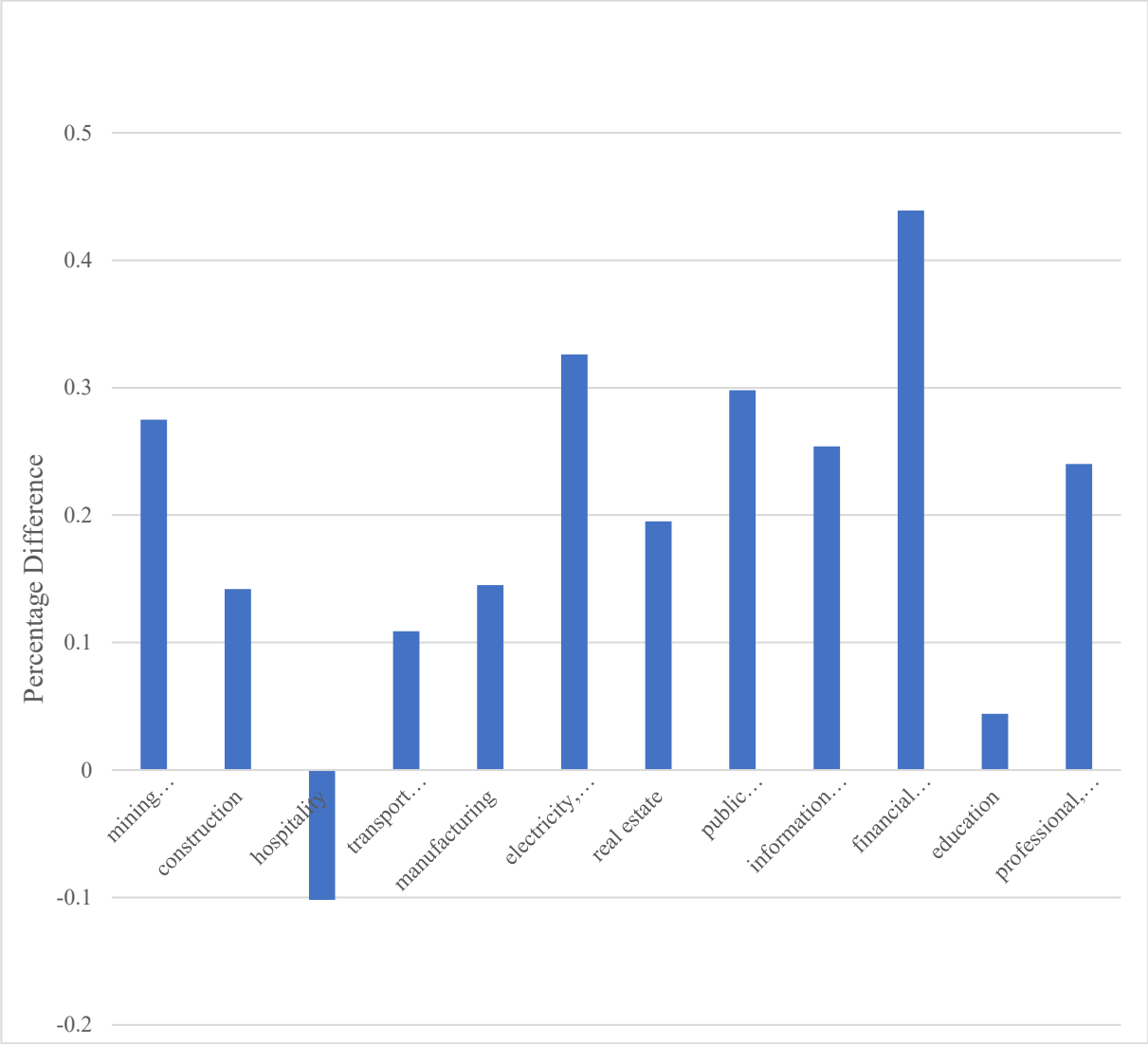
As discussed, one of the only sectors in which earnings are lower than for the retail and wholesale trade sector is for the similarly lower skilled hospitality sector, where average hourly earnings are 11.7 percent lower. The finding may be of some concern as Appendix 1, Figure 1 shows the retail and hospitality sectors employ a combined 17 per cent of the New Zealand workforce, with the retail sector accounting for 10 per cent of this share. Additionally, Appendix 4 shows the retail and accommodation and food service (hospitality) sectors are particularly female-dominated industry. Policies to increase earnings for these industries in particular, may improve standards of living for many households.

Table 4. Industry Average Hourly Earnings Differences Grouped by Average Industry Skill Level. Dependent variable: Log Average Hourly Earnings

Average Industry Skill Level	Industry	Hourly Average Earnings
Lower Skilled	*household activities*	0.163
		(0.123)
	mining and quarrying	0.275***
		(0.105)
	construction	0.142***
		(0.025)
	hospitality (accommodation and food services)	-0.102***
		(0.020)
Lower-to-Medium Skilled	*agriculture, forestry and fishing*	-0.036
		(0.030)
	water, sewerage and waste	0.042
		(0.088)
	transport and storage	0.109***
		(0.037)
	manufacturing	0.145***
		(0.025)
	electricity, gas, steam and air conditioning	0.326***
		(0.096)
	real estate	0.195**
		(0.097)
Medium Skilled	*administration and support services*	-0.030
		(0.033)
	public administration, defence and social services	0.298***
		(0.026)
	other service activities	-0.035
		(0.047)
Medium-to-Higher Skilled	*health and social services*	0.016
		(0.025)
	information and communication	0.254***
		(0.052)
	financial and insurance services	0.439***
		(0.050)
	arts, entertainment and recreation	0.032
		(0.055)
Higher Skilled	*education*	0.044*
		(0.026)
	professional, scientific and technical services	0.240***
		0.034)
Control variables:	*yrsqual*	0.062***
		(0.003)
	years work experience	0.025***
		(0.002)
	years work experience squared	-0.000***
		(0.000)
	cons	1.90***
		(0.000)
Number of observations		3,578
R-squared		0.35
Mean VIF		2.36

Notes: Dependent variable is average hourly earnings. Base group is wholesale and retail trade (highest number of industry observations of 605, and lowest VIF multicollinearity results). Robust standard errors in parenthesis. *** statistical significance at the 1% level, ** significance at the 5% level, * significance at the 10% level.

Figure 2. Percentage Differences in Average Hourly Earnings by New Zealand Industry, Relative to the Retail Sector



Notes: Figure 2 presents the statistically significant regression results from Table 4 in graphical form.

5.5. Age and Gender Effects on Average Hourly Earnings.

It is important in this study also to examine the effects that age may have for earnings. This will be examined in hypothesis four, testing that individual earnings will rise with increases to age in the New Zealand labour market. Hypothesis five will also be tested through gender interactions with age groups where male workers are expected to earn higher wages than female workers in the New Zealand labour market. It is expected that workers will earn more as age increases, as factors including job-specific skills, responsibility level and experience improve worker earnings. Of these factors, only the effects of experience have been modelled for in the previous sections. This is principally

through the explanatory variables of total years of work experience (*totyrswrkexp)* and its' polynomial (*totyrswrkexp^2).* Including age as a variable assists in capturing these other factors, within a broader measure. This research will also contribute to the literature in identifying the age group representing peak earnings, both by overall age and by gender. This will allow analysis for why this particular age bracket may experience the highest average earnings. Table 5 shows the descriptive statistics for average hourly earnings by age and by gender for the New Zealand workforce as collected from the OECD's PIAAC survey in 2014 to 2015 period. The respondents were asked which of five age brackets they belonged to. These are: aged 24 or less, aged 25 to 34, aged 35 to 44, aged 45 to 54, and aged 55 plus. This same data is not available from Statistics New Zealand for comparative purposes.

The results support the hypothesis that earnings will increase with age. For rows 2 to 6 presenting hourly earnings by age bracket, Column 3 shows that while average hourly wage rates continue to rise up until the 55 plus age bracket, the most significant increase in earnings occurs for the 35 to 44 year age bracket. Here average wages reach $28 per hour and only increase marginally in the higher age brackets. This result is clearer when considering median hourly wage rates in Column 4. The highest median wage is $24.04, for those in the 35 to 44 year age bracket. Median average wage rates display the typical U-shaped profile observed in the literature, including in work by Mincer (1974) and Thornton, Rodgers and Brookshire (1997). This may provide some argument that, while a U-shaped profile is observed, peak earnings occur for perhaps a lower age bracket for the New Zealand labour market, rather than the more senior and experienced age categories the literature tends to indicate. Average earnings reach the $28.00 range and a median wage rate of $24 in the 35 to 44-year bracket and do not increase materially beyond these rates in the higher age groups.

Gender effects may be playing some part in this pull downwards towards a younger peak earnings age group. Rows 11 to 12 present wage rate information by age and gender. Average hourly earnings for male workers continue to grow throughout the age categories, from $16.70 for those aged 24 or less, to an average of $32.60 for those aged 55 and over. Female workers, in contrast, experience a plateauing of wage rates at the 35 year age bracket of $26. Average rates fall to $25.84 for those aged 55 and over.

Median hourly wage rates tell a similar story with a highest rate of $22.50 for those in 35 year age bracket. Female wage rates display a pattern closer to the U-shaped wage profile than do male average wage rates. The results raise questions as to the importance of factors such as experience for earnings in the New Zealand labour market. Traditionally, experience is expected to raise worker earnings where the highest earnings occur for those in the 45 year and higher age brackets. Possible reasons for a lower peak earnings category may include less importance for experience, a greater value for the qualifications and skill of younger workers, or possibly age discrimination. These findings suggest avenues for further research.

The results fully support hypothesis five where male workers are expected to earn higher wages than female workers in the New Zealand labour market. Rows 8 and 9 show that female workers are paid $3.05 per hour less than males, on average, in Column 3. The difference for the median wage is slightly less at $2.23 per hour, in Column 4. Males earn more than females in each age group for both the average and median hourly rate, and this difference grows by age group. There is $1 median wage difference between males and females aged 24 or less. This grows to a $4.60 difference in the median rate for female and male workers aged 55 and over.

The results show a growing variance in, or dispersing of earnings by participants in the labour market for each age group. There is a range of $3.92 for those aged 24 or less between the 25th to the 75th percentile presented in Column 5. This increases to $15.60 for workers aged 45 to 54 years. The variance in wages falls slightly to $13.70 for those aged 55 and over. By gender, the variance in wage rates grows for males from $4.70 for the youngest cohort to $16 per hour for those over 55 years of age. This is a difference in variance from the oldest to the youngest group of $11.32. Female workers see arguably less variance in earnings with a difference in the youngest and oldest age groups of $9.36. These results indicate that not all are sharing uniformly in the labour market. This arguably reflects the working of a flexible labour market but perhaps some greater homogeneity or equality in earnings would help lift overall income levels. These findings indicate a trend in the New Zealand labour market for a greater value for the skills of mid-age workers, with less acceptance of the value of younger and older workers, and particularly for female workers. This indicates a need for policy to promote

the value of this large proportion of the workforce to raise overall earnings potential in the economy.

Table 5. Hourly Earnings by Age and Gender for the New Zealand Labour Market.

Age (1)	No. of observations (2)	Average hourly wage rates ($) (3)	Median hourly wage rates ($) (4)	Interquartile Range (5)	
				25%	75%
24 years or less	708	16.79	15.50	14.25	18.17
25 to 34 years of age	719	24.74	21.63	17.00	28.13
35 to 44 years of age	817	28.09	24.04	18.00	32.17
45 to 54 years of age	736	28.50018	23.90	17.50	33.08
Aged 55 plus	603	28.70	23.50	18.00	31.70
By Gender					
Males	1,601	27.06	22.23	17.21	30.67
Females	1,982	24.01	20.00	15.63	27.40
Age and Gender Interactions					
Males aged 24 or less	344	16.70	16.00	14.27	18.95
Males aged 25 to 34	335	25.65	23.00	18.03	30.77
Males aged 35 to 44	366	30.36	25.64	20.00	33.90
Males aged 45 to 54	301	31.47	26.22	20.00	26.22
Males aged 55 plus	255	32.59	26.22	20.00	36.00
Females aged 24 or less	364	16.64	15.00	14.25	17.89
Females aged 25 to 34	384	23.95	20.14	16.34	26.00
Females aged 35 to 44	451	26.25	22.50	16.76	30.00
Females aged 45 to 54	435	26.45	22.50	16.67	31.25
Females aged 55 plus	348	25.84	21.63	17.00	30.00

Notes: Dependent variable = Average Hourly Earnings. PIAAC Survey Descriptive Data. Comparable data for earnings by age and gender is not available from Statistics New Zealand.

6. Summary and Policy Implications

Previous studies have applied years of schooling, or qualifications, as the dominant measures of the effects of human capital for earnings. This study builds on these findings and contributes to the literature in applying more recently available data to examine the effects of core skills for earnings, for the New Zealand labour market and economy. This research also takes a differing path from work in skills mismatch effects which

applies skills proficiency data in predicting the effects of under or over-education for worker earnings. The principal human capital measures used in this research are the degree of skill proficiency and the use of the core skills of literacy, numeracy and ICT problem-solving for earnings for the New Zealand labour market.

The results obtained support the main hypothesis whereby an increase in proficiency of the core skills of literacy, numeracy, and ICT problem-solving improve earnings, with the largest positive effect from ICT problem-solving skill. Numeracy skill proficiency has the second-largest positive impact for worker earnings, followed by literacy. For the more novel element to this study of evaluating the impact of the frequency of use of the core skills for earnings, an increase in the frequency of use of ICT problem-solving in work tasks has a significant and positive effect for earnings. This result is consistent for each of the regressions in this chapter, supporting the robustness of results obtained. Some evidence is also found for improved worker earnings when there is greater use of numeracy and reading skills in the workplace. These earnings effects will not just occur and it would be expected that they reflect the level of demand for these skills and their use in tasks in the New Zealand labour market.

Important control variables and other variables of interest include the traditional years of schooling and experience variables which show consistently positive and significant effects for earnings, as expected from the literature. A very important result obtained is that further adult education and training that is job related increases worker earnings. This indicates an area for policy to consider the further development of programmes aimed at supporting workers' ongoing educational opportunities over and above foundational studies and workplace training, to improve their earnings potential. Evidence is also found for a positive relationship between learning at work, or training activities, and earnings. This finding supports the importance of these programmes within New Zealand workplaces for lifting productivity and the earnings potential for both firms and their workers.

The available data also allows for an evaluation of the differences in earnings by occupational skill category in this chapter. Expected earnings differentials are observed, relative to a base group of skilled workers. The largest difference in earnings is found

between elementary skilled and skilled occupations. A point of interest and further contribution of this research is that a uniform gradient earnings effect is not observed between the occupational groups. A smaller earnings gap is found for blue collared workers than for white collared workers, relative to the base group. Reasons for this may include differences in compensation for working conditions for occupations in the blue collared industries, and also any possible 'hollowing out' effect that may be occurring in the New Zealand work force. This is in line with Levy and Murnane's (2004) observation of the loss to automation of substitutable and 'middle-range' tasks typically found in white collared positions such as clerical work and data-processing. There is argument for improving the skill and value for workers in each occupational skill category to not only improve earnings but also reduce any structural unemployment effects that may be occurring.

The effects of average industry skill level on worker earnings are next evaluated. The results support the hypothesis with a rise in earnings as industry skill level increases. The lowest relative earnings occur for the lower skilled sectors of retail and food and accommodation (hospitality). As evidenced, these two sectors employ a significant proportion of the workforce, and in particular female workers. These findings support the need for policy to lift earnings for workers particularly in these lower skilled occupations. A persistent and negative finding that prevails in the results for this chapter is the earnings gap that exists for female workers relative to males. This poses a significant constraint for raising income in the workforce, households and the economy in closing New Zealand's income gap to other countries. Female workers are particularly hard hit for earnings differences in the occupational skill categories in comparison with males. This is a reflection of factors other than skills impacting on gender earnings.

Finally, the differences in earnings by age are considered, together with interactions to capture gender effects. Overall, peak earnings are for those in the 35 to 44-year age group, with some influence from gender effects. For males, a tapering effect is observed with the strongest average hourly earnings increases for the 35 to 44-year group, followed by smaller increases through to the 55 plus year group. For female workers, the more traditional U-shaped age profile is observed, with a clear peak earnings level at the 35 to 44-year age bracket. These findings indicate a pulling down

of overall peak earnings by female earnings. As this level occurs at a relatively young age in the working life, and particularly for female workers, it indicates a loss of potential earnings for the New Zealand economy in undervaluing a significant section of the workforce. The results may also point to possible discrimination for older workers and for female workers.

The results in this study show the significant positive value that improvements in the core skills can have to the earnings potential for the New Zealand workplace. It also highlights the importance of technology through ICT problem-solving skills and the need for workers to develop and maintain proficiency in their use of these skills, together with improved numeracy skills. The identified relative gap in average earnings for lower skilled and white collared workers highlights the need for policy to address both skill deficits and for greater skill recognition, with the gap in female earnings being a paramount concern.

The findings support a set of policies required to enhance the proficiency in core skills of literacy, numeracy and ICT problem-solving skills in the New Zealand population. This will enable more workers to shift into roles with demand for these skills, supporting increases to individual earnings. The results suggest the greatest potential benefits may come from an increased numeracy and ICT skill proficiency, and reshaping of the workplace around more intensive ICT use. Policy should encourage participation in higher education. This will support an increase in the proportion of the workforce with higher level qualifications, helping to build the cognitive skills needed for problem-solving activities and tasks. Current New Zealand Government policy to support these aims include making tuition fees free for the first year of University study [6]. This policy should provide encouragement for those who face barriers to tertiary study by reducing financial constraints.

The fees free program also allows for up to two years' fees free study for those enrolling in industry-based training. A strong emphasis on vocational training is evident

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[6] The New Zealand Government introduced Fees Free, targeted at first-time learners to tertiary education, in 2018.

in Government policy, as outlined by the New Zealand Ministry of Business, Innovation and Employment (MBIE, 2019), in setting out the Government's employment strategy. This will likely reduce industry skills shortages and provide further pathways for those whose skills and abilities are better suited to vocational careers. However, some consideration may be taken of the findings of Lavrijsen and Nicase (2017) in their study of thirteen OECD countries. Here, higher early labour market earnings benefits are experienced from vocational specialisation, but these are found to decrease over time. It will be important that individuals are equipped with the general knowledge, skills and competencies, including numeracy and literacy skills, considered to be foundational for lifelong learning. These skills are generally developed in a University setting and, as evidenced from the literature readings, are often supportive of higher earnings.

The strong results for earnings evidenced in the results for further formal and informal adult education and training supports the importance of policy to support lifelong learning. Government programs are being developed to provide for this and are being delivered through schools, communities, Te Pukenga [7] and Te Wananga o Aotearoa [8]. These programmes are aimed at improved employability and include courses in financial literacy, languages, literacy, numeracy and digital literacy. These are important initiatives, and it is important they reach a sufficient cross-section of the community to support the needed up-skilling. The fees free and vocational programmes discussed should support younger members of society in particular in developing the skills they need for the modern New Zealand workforce, to improve their earnings potential. Support should also be provided for older citizens who seek to retrain and to gain University qualifications. This can often be difficult as the levels of other commitments increase with age.

To support the increased earnings observed from greater use of information communication technology it will be important that a well-developed connectivity

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[7] Te Pukenga is the New Zealand Institute of Skills and Technology, a public tertiary education provider that aims to provide the opportunity for individuals to learn and train through their lifetimes, supporting the needs of firms and industries in providing vocational learning opportunity. https:www.tepukenga.ac.nz. [8] Te Wananga o Aotearoa is a uniquely Maori learning environment available for all New Zealanders that aims to provide training and learning opportunities for those who have experienced difficulty with the mainstream education system.

infrastructure is in place. The Government's target is 99.8 per cent of New Zealand's population to be able to access improved broadband by the end of 2023. There is a 64 per cent uptake of ultra-fast broadband services as at 31 March, 2021 [9].

The results of this study have highlighted the gender pay gap that exists in the New Zealand workforce. Government policy to correct for this includes the Equal Pay Act 1972. The Act requires that men and women doing work requiring the same, or substantially similar skill, effort, responsibility and working conditions are paid the same. Policy also requires that employment and workplace relations should be based on demonstrating good faith, natural justice, human rights, and good employer practice, as well as meeting legal requirements [10]. As for many countries, such provisions are not sufficient to close the gender gap which will require ongoing policy measures in areas including flexibility in working arrangements and hours, more supportive childcare arrangements (as signalled in the 2019 MBIE report) and workplace gender rebalance. Equally, to address the lower income observed in the results for younger and older workers and any possible age discrimination that exists in the New Zealand workplace, New Zealand employment law is established to prevent discrimination by age at work [11]. However, little other policy exists for older workers other than to encourage their employment by firms for their experience and other valuable attributes. Policy to correct for any devaluing of workers based on age is required to provide for equal opportunity regardless of age.

Finally, efforts to increase earnings for those in the lower skilled industries of retail, and food and accommodation, with a large proportion of female workers, and in which a sizeable proportion of the New Zealand workforce are employed, may help to

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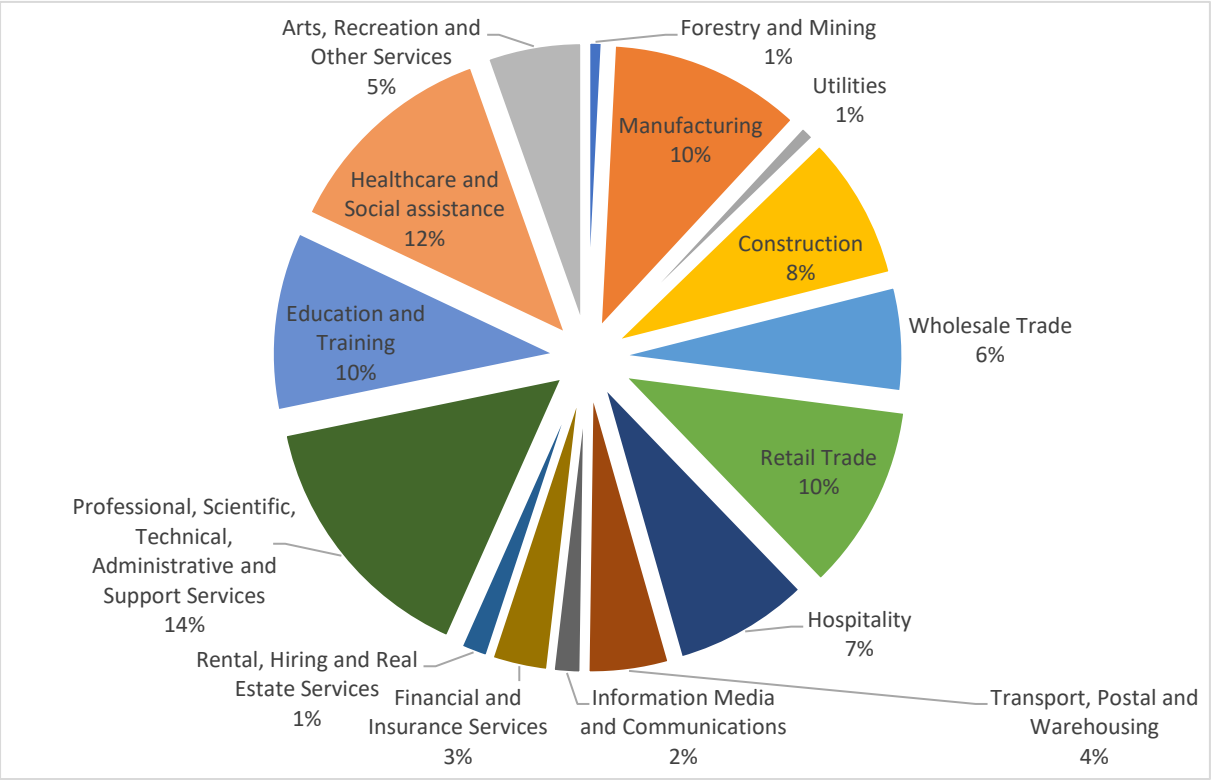
[9] As provided in the Crown Infrastructure Partner's Quarterly Connectivity Update for the first quarter, 2021. Progress information for mobile black spot connectivity is disaggregated. https://www.mbie.govt.nz/dmsdocument/14891-quarterly-connectivity-update-q1-to-31-march-2021. [10] Employment in NZ Gender Pay Gap https://www.employment.govt.nz/hours-and-wages/pay/pay-equity/gender-pay-gap/. [11] Common examples of age discrimination protected against under New Zealand law include an employer thinking someone: cannot manage technology or learn new skills because they're older; will not fit in with the company culture because they are not the same age as other staff; cannot be included in staff schemes, such as insurance or healthcare because of their age. https://www.govt.nz/browse/work/workers-rights/age-discrimination-at-work.

lift household income. From the results obtained, such policy may include greater integration of ICT into these sectors in a way that is not job depleting. Each of these policy initiatives should support growth in earnings and productivity in the New Zealand workforce to improve future economic growth and support higher levels of household standards of living.

Appendices

Appendix 1. Figure 2. Five-Year Average Share of Total Employment for New Zealand Industries for 2016 to 2020



Source: Statistics New Zealand. Infoshare: Filled Jobs by Industry, ANZIC06 series, from the earnings and employment survey (QEM).

Appendix 2.

Appendix 2 shows the participating countries for the first cycle of the PIAAC Adult Skills Survey. 39 countries/economies participated in the first cycle of the survey conducted between 2011-2018. The survey focused on skills in three domains: literacy, numeracy, and problem solving in technology-rich environments. There were three rounds for survey data collection. New Zealand was included in the second round. The second cycle is scheduled to take place over the 2022 to 2024 period.

Participating Countries in the PIAAC, First Round Surveys

PIAAC 1st Cycle	**Round 1 (2011-2012)**	Australia, Austria, Belgium (Flanders), Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea, Netherlands, Norway, Poland, Russian Federation, Slovak Republic, Spain, Sweden, United Kingdom (England and Northern Ireland), United States
	Round 2 (2014-15)	Chile, Greece, Indonesia, Israel, Lithuania, New Zealand, Singapore, Slovenia, Turkey
	Round 3 (2017)	Ecuador, Hungary, Kazakhstan, Mexico, Peru, United States

Notes: Source: https://www.oecd.org/skills/piaac/about/piaac1stcycle/

Appendix 3.

Appendix 3 shows the survey sample numbers for workers employed in each New Zealand industry from the PIAAC survey data. The observation count was taken in determining suitable industries to use as a base year in regressions. Criteria included a relatively large industry employment base, to aid in robustness. The wholesale and retail (*wholesaleretail)* industries are grouped together in the survey data and provided the largest observation count. These industries are also in the lower skilled category which was considered a suitable base skill grouping. Wholesale and retail is chosen as the base group for these criteria. Other industries such as manufacturing (477) were also used as the base group with similar results.

Number of PIAAC Survey Observations by New Zealand Industry

Industry	Observations
agriforfish	270
miningquarry	18
manufacturing	477
elecgassteamaircon	22
watersewwaste	18
construction	339
wholesaleretail	605
transportstorage	173
accommodationfoodserv	285
informationcomm	178
financialinsurance	114
realestate	54
profscientifictech	264
adminsupportservices	163
publicadmindefencesocsec	242
education	497
healthsocservices	549
artsentertainmentrec	97
otherservactivities	86
householdactivities	6

Note: The count by industry is intended to represent worker participation in each industry in the sample. The wholesale and retail sectors show the greatest number of observations, supporting their choice as base group in regression equations.

Appendix 4.

Appendix 4 shows the five-year average for 2017 to 2021 of New Zealand industry total shares of employment by gender, and gender shares of part-time and full-time employment for each industry. Males have a greater employment share in heavier industry including manufacturing, utilities, transport, postal and warehousing and wholesale trade. By the ANZOC classification system used these are lower to medium skilled industries. Females have greater employment shares in industries including retail, hospitality, healthcare and social assistance and education and training. Females also have a greater proportion of part-time employment for all industries presented.

New Zealand Industry Employment Shares by Gender, Full-Time and Part-Time. Five-Year Average, 2017-2021.

			Male		Female	
Industry	Total Male Employment %	Total Female Employment %	Part time %	Fulltime %	Part time %	Fulltime %
Forestry and Mining	83	17	6	94	34	66
Construction	85	15	4	96	29	71
Retail	40	60	30	70	48	52
Hospitality	39	61	51	49	62	38
Manufacturing	72	28	4	96	18	82
Utilities	71	29	5	95	15	85
Wholesale Trade	64	36	6	94	25	75
Transport, Postal and Warehousing	71	29	14	86	25	75
Information Media and Telecommunications	52	48	17	83	28	72
Financial and Insurance Services	43	57	5	95	17	83
Healthcare and Social Assistance	18	82	28	72	44	56
Public Administration and Safety	47	53	9	91	15	85
Professional, Scientific, Technical, Administrative and Support Services	50	50	18	82	33	67
Education and Training	26	74	25	75	39	61
Arts, Recreation and Other Services	45	55	20	80	49	51
Total All Industries	49	51	15	85	38	62

Notes: Filled jobs by industry (ANZSIC06) by gender and status by employment. Source: infoshare.stats.govt.nz

Bibliography

Adalet, M., and Andrews, D. (2015). Skill mismatch and public policy in OECD countries. *OECD Economics Department WP 1205.*

Acemoglu, D., and Autor, D. (2011). Skills, tasks and technologies: Implications for employment and earnings. *Handbook of Labor Economics, 4,* 1043-1171.

Australian Bureau of Statistics. (2015). Australian system of national accounts. Concepts, sources and methods. *Australian Bureau of Statistics, Canberra.* https://www.abs.gov.au/ausstats/abs@.nsf/mf/5216.0

Barro, R., and Lee, J. (1996). International measures of schooling years and schooling quality. *The American Economic Review, 86,* 218-223.

Bartel, A. (1995). Training, wage growth and job performance: Evidence from a company database. *National Bureau of Economic Research, WP. 4027.*

Boll, C., Jahn, M., and Lagemann, A. (2017) The gender lifetime earnings gap-exploring gendered pay from the life course perspective. *Hamburg Institute of International Economics, Paper 179.*

Carbonaro, W. (2006). The effects of education and cognitive skill on earnings: How much do occupations and jobs matter? *Research in Social Stratification and Mobility, 25,* 57-71.

Chiswick, B.R., and Mincer, J. (1972) Time-series changes in personal income inequality in the United States from 1939, with projections to 1985. *Journal of Political Economy, 80,* S34-S66.

Denison, E. (1962). Education, economic growth, and gaps in education. *The Journal of Political Economy, 70,* 124-128.

Duncan, G., and Hoffman, S. (1981). The incidence and wage effects of overeducation. *Economics of Education Review, 1,* 75–86.

Green, J., Hand, J., and Zhang, X. (2017). The characteristics that provide independent information about average U.S. monthly stock returns. *The Review of Financial Studies 30,* 4389-4436.

Guo, N. (2022) Hollowing out of opportunity: Automation technology and intergenerational mobility in the United States. *Labour Economics, 75,* 102136.

Jorgenson, D., Gollop, F., and Fraumeni, B. (1987). Productivity and U.S. economic growth. *Elsevier Science. Amsterdam.*

Kidd, N. (2008). Putting productivity first. *New Zealand Treasury WP 08/01.*

Krugman, P. (1997). The age of diminished expectations: U.S. economic policy in the 1990s. *MIT Press Books.*

Levy, F., and Murnane, Richard J. (1992). U.S. earnings and earnings inequality: A review of recent trends and proposed explanations. *Journal of Economic Literature, 30,* 1333–1381.

Lowenstein, M., and Spletzer, J. (1996). Informal training: a review of existing data and some new evidence. Bureau of Labor Statistics.

McGowan, M., and Andrews, D. (2015). Labour market mismatch and labour productivity. *OECD Economics Department WP 1209.*

Mincer, J. (1974). Schooling, experience, and earnings. *National Bureau of Economic Research, Chapter pages in book:* 41-63.

Murphy, K., and Welch, F. (1990). Empirical age-earnings profiles. *Journal of Labour Economics, 8,* 2.

New Zealand Government. Age discrimination at work. https://www.govt.nz/browse/work/workers-rights/age-discrimination-at-work/

New Zealand Ministry of Business, Innovation and Employment (2020). Gender pay gap. Employment New Zealand. https://www.employment.govt.nz/hours-and wages/pay/pay-equity/gender-pay-gap/

New Zealand Productivity Commission. (2009). Answering the $64,000 Question. Closing the income gap with Australia by 2025. 2025 Taskforce. *New Zealand Government.* https://www.treasury.govt.nz/sites/default/files/2017-11/2025tf-summary-nov09.pdf, 7.

New Zealand Tertiary Commission. (2019). Literacy and numeracy implementation strategy, 2015-2019. https://www.tec.govt.nz/assets/Publications-and-others/c74aff1b80/Literacy-and-Numeracy-Implementation-Strategy-2015-2019.pdf

OECD. (2016). The survey of adult skills. Reader's companion, second edition. *OECD Publishing, Paris.* https://www.oecd.org/publications/the-survey-of-adult-skills-9789264258075-en.htm

OECD. (2016). Technical report of the survey of adult skills (PIAAC). 2nd Edition. https://www.oecd.org/skills/piaac/_Technical%20Report_17OCT13.pdf.

OECD. (2016). Skills matter: Further results from the survey of adult skills. New Zealand. *https://www.oecd.org/skills/piaac/Skills-Matter-New-Zealand.pdf*

OECD. (2017). Note in their Compendium of Productivity Indicators. *OECD Publishing, Paris.*

Oxley, L., Le, T., and Gibson, J. (2008). Measuring human capital: Alternative methods and international evidence. *The Korean Economic Review, 20.*

Pellizzari, M,. and Fichen, A. (2013). A new measure of skills mismatch: Theory and Evidence from the survey of adult skills (PIAAC). *OECD Social, Employment and Migration. OECD Publishing, Paris, WP153.*

Statistics NZ. (2018). Filled jobs by industry (ANZSIC06). http://infoshare.stats.govt.nz.

Statistics NZ. (2019). Australian and New Zealand Standard Classification of Occupations (ANZSCO). https://www.stats.govt.nz/methods/australian-and-new-zealand-standard-classification-of-occupations-anzsco

Thornton, R., Rodgers, J., and Brookshire, M. (1997). On the interpretation of age-earnings profiles. *Journal of Labour Research, 18,* 2.