Workplace safety and the future of work in New Zealand

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Executive Summary

What are the possible implications of future-of-work trends for workplace health and safety (WHS)? Despite presenting potentially significant challenges and opportunities, these implications have thus far received scant attention. This report adds to the evidence in this area and provides NZ-specific insights. It examines the relationship between future-of-work trends and WHS outcomes, with a focus on safety outcomes using information on work-related injury claims. We take advantage of Stats NZ's integrated data, which provides rich information on work-related injuries that can be related to the characteristics of workers and their workplaces via an extensive set of linked administrative and survey data. This includes key future-of-work explanatory variables drawn from the Business Operations Survey 2018's module on the 'Changing nature of work'.

Our main results use multivariate regressions to examine work-related injury claim rates and injury severity (as measured by medical costs and number of compensated days off work) using 2018 ACC data. The regressions include a wide set of explanatory variables, including individual socio-demographic factors (e.g. age, gender, ethnicity), individual economic variables (e.g. job tenure, earnings, multiple jobs held), general firm characteristics (e.g. industry, firm size, firm age) and firm-level variables that are particularly relevant to the future of work (e.g. level of automation, flexible work practices). When interpreting the results, some caveats should be noted. Our regression results examine associations, not causal relationships. Moreover, some potentially important factors, such as hours worked and occupation, are not included due to data limitations.

Focussing on the main multivariate regressions, which control for all available worker and firm characteristics, some key findings are:

- **Gender:** Male workers have a higher likelihood of having a work-related injury claim and their injuries tend to be more severe (in terms of greater medical costs and compensated time off work) than female workers. This could mean that work-related injury rates decrease as female employment continues to rise.
- **Age:** Work-related injury claim rates and injury severity tend to increase with age, which presents a potential challenge for workplace safety given the ageing workforce.
- **Ethnicity and born in NZ:** Māori and Pasifika workers have a higher likelihood of having a work-related injury claim than Europeans, but when they do have an injury claim, the measured injury severity is not higher than Europeans (in fact, severity is lower in the case of Pasifika workers). There are no statistically significant differences in injury claim rates between those who were and were not born in NZ.

- **Job tenure:** The injury claim rate decreases as job tenure increases, but the injury severity measures generally do not differ by job tenure.
- **Industry:** In line with expectations, workers in industries which have been identified as priorities for WHS, such as agriculture, forestry & fishing, have a relatively high likelihood of having an injury claim. Workers in service industries tend to have relatively low injury claim rates.
- **Firm size:** In general, we do not find that injury rates are higher for workers in smaller firms.
- **Automation:** Consistent with the notion that automation removes workers from potentially hazardous situations, workers in firms with higher levels of physical task automation have lower injury claim rates.
- **Flexible working arrangements:** Workers in firms that offer working-from-home options have lower workplace injury claim rates. In addition, female workers in firms with flexi-time options have lower workplace injury claim rates.
- **Other future-of-work variables:** With a few exceptions, the coefficients on most of the other future-of-work variables are not statistically significant, including most variables relating to leave arrangements, employee engagement and workplace policies and practices. However, this does not necessarily mean that these factors are unimportant as the insignificant findings could be in part due to the nature of the data, which provides information on whether a business has a relevant practice in place but not how commonly it is used. The relationships may also change over time as the examined practices become more commonplace, particularly given that Covid-19 has been a catalyst for normalising practices such as flexible working arrangements.

Our analysis also examined patterns of work-related injury claims before and after the introduction of the Health and Safety at Work Act 2015 (HSWA) and find no significant change. However, this is unsurprising given the relatively short time since it came into effect and the expectation that associated changes would be gradual as cases are tested in the courts, associated regulations continue to be developed and further guidance and enforcement implemented.

Overall, this study focuses on firm-level future-of-work variables available in BOS. However, to complement this study, future research could use the Household Labour Force Survey (HLFS) to include information on hours worked and occupation, as well as individual-level future-of-work variables such as contract type, perceived job security and autonomy and flexible work arrangements (available every four years via the HLFS Survey of Working Life supplement).

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1 Introduction

What are the possible implications of future-of-work trends for workplace health and safety (WHS) in New Zealand (NZ)? The future of work involves a confluence of several meta-trends. Technological advances are creating new production processes and products. In turn, these advances are facilitating new approaches to delivering products and services. These approaches interplay with changes in workplace practices, such as increases in non-standard work and flexible working arrangements. Importantly, these trends are occurring against a backdrop of broader demographic, environmental and economic changes that are influencing work patterns, examples of which include population ageing, climate change and globalisation.

Despite presenting a potentially significant challenge, the possible implications for WHS of future-of-work trends have so far received scant attention. Moreover, NZ-specific insights are needed since while NZ faces the same general future-of-work trends as other developed countries, some of the specifics as well as the regulatory context differ. This report, therefore, empirically examines the cross-sectional relationship between future-of-work trends and workplace safety outcomes. We take advantage of Stats NZ's integrated data, which provides rich information on work injuries which can be related to the characteristics of workers and their workplaces via an extensive set of linked administrative and survey data.

This investigation of the relationship between workplace safety outcomes and worker and workplace characteristics is aimed at providing insights into potential areas of challenge or opportunity given potential future-of-work trends. For example, a positive relationship between workplace injury rates or severity and worker age may raise concerns given that the population continues to age. It would be speculative to project what future-of-work will be seen going forward. Indeed, we even lack a picture of how many future-of-work trends have evolved up to this point due to data limitations. However, based on the estimated relationships between future-of-work variables and injury claim rates, this report illustrates how some plausible changes to factors such as the gender, age and industry composition may change the work-related injury claim rate.

The remainder of this report is organised as follows. The next section provides some context and background on NZ's WHS policies and outcomes as well as general and NZ-specific future-of-work trends. Section 3 outlines the data used and presents some summary statistics. Section 4 presents results, first looking at bivariate relationships between work-related injury claims and worker and firm characteristics as a benchmark and then extending this to multivariate regressions given the interplay of explanatory variables such as age and job tenure, or gender and industry, for example. Section 5 looks at the patterns of work-related injury claims over time and examines whether injury rates changed following WHS regulatory changes, particularly the introduction of the Health and Safety at Work Act 2015 (HSWA). Finally, Section 6 concludes with a discussion of relevant caveats and directions for future research.

2 Context and background

This section outlines several key aspects of NZ’s WHS context and regulatory environment, as well as relevant global future-of-work trends, accompanied by a brief discussion of the NZ-specific experience. A fuller discussion of relevant future-of-work trends and the existing literature on their potential implications for WHS is provided in an interim report that was produced as part of this project (Meehan, Pacheco & Watson, 2020).

2.1 WHS policy background in NZ

NZ has a high level of work-related harm by international standards. After adjusting for industry composition, NZ’s worker fatality rate is similar to Australia’s and higher than the UK’s and Sweden’s (WorkSafe, 2017). In 2018, there were almost 240,000 work-related injury claims, amounting to just over one claim per 10 full-time-equivalent workers. This included 81 claims for fatal work-related injuries. Although outside the scope of this report, workplace harm extends beyond injuries at work and it is estimated that 750-900 people die every year from work-related ill health and that there are 5,000-6,000 work-related health hospitalisations a year (WorkSafe, 2019). Moreover, these estimates only cover the most readily quantifiable forms of harm. For example, harm (including psychological) stemming from psychosocial risk factors - which is a growing concern in workplaces - will often not be captured by these statistics.

Against the backdrop of existing concern about high work-related harm in NZ, the 2012 Pike River disaster was a catalyst for policy change. An Independent Taskforce on WHS reviewed NZ’s system and called for an urgent step change in harm prevention and a dramatic improvement in outcomes. It recommended major reform of health and safety legislation and the establishment of an independent regulator. This informed the establishment of WorkSafe in 2013 as the primary regulator. It also informed the Health and Safety at Work Act (HSWA) 2015, which is an overarching piece of legislation with higher penalties for key offences, new duties on business leaders and new compliance tools. The basis for this legislation was the Australian Work Health and Safety Act 2011, which was developed from the Lord Robens et al. (1972) report and the resulting UK Health and Safety at Work Act 1974 (Peace, Mabin & Cordery, 2017). It is premised on self-regulation and performance-based standards rather than prescriptive requirements (Sherriff & Tooma, 2010).

ACC is another important organisation in NZ’s WHS architecture. Established in 1974, ACC administers NZ’s accident compensation scheme, which is unique internationally. ACC is the sole provider of accident insurance and participation in the scheme is compulsory. The ACC system is a universal no-fault scheme, which removes the right to sue (except for exemplary damages in some cases). In contrast, compensation schemes in other countries typically cover only workers, and in many cases, exclude certain types of workers, such as the self-employed, those in small businesses and independent contractors (Poland, 2018). In addition to treatment costs, ACC provides income compensation if workers require more than a week off work to recover from an injury, whether their injury occurred at work or not. In other countries, such as Australia, Canada and the United States, injured people are only entitled to income compensation if the injury occurred at work. As well as providing a range of entitlements to injured people, ACC also undertakes injury prevention promotion. ACC is funded via a combination of levies and government contributions. These include work-related levies collected from employers and the self-employed, employees and via petrol and motor vehicle licence fees, as well as government contributions from general taxation for non-earners.

2.2 An overview of relevant future-of-work trends

The future-of-work encompasses a confluence of meta-trends affecting how goods and services are provided and the ways in which people work. These meta-trends include technological advances that are affecting the way goods and services are produced and delivered and the ways in which people work due to the ability to work remotely and the ability to move away from a traditional employer-employee work relationship via trends such as platform/gig-economy work. It also includes globalisation, which is associated with trends such as the rise in global value chains and the increased global mobility of the factors of production, including workers. Social and demographic shifts, such as the ageing population and increasing female labour force participation, are also driving changes in the way people work through, for example, part-time and more flexible working arrangements. Regulatory factors are also playing a role, such as the de-regulation of the labour market and of key industries, such as transportation, utilities and finance, in many countries. These factors and others, such as the need to respond to climate change, are interacting to create a host of factors that fall under the future-of-work umbrella.

What future-of-work trends are potentially relevant to WHS? This subsection provides an overview of some of these issues, with a focus on the consequences (rather than drivers) of these trends for workers and workplaces that can be measured to some extent with the existing data. These issues are discussed under four broad categories of change: demographic, industrial structure, non-standard work, new organisational workplace practices and technological change. This delineation is, however, mostly for practical purposes as, in reality, these particular trends are often inter-related, and driven by a combination of various meta-trends. For example, technological and regulatory changes have facilitated the rise of non-standard work via the gig economy.

This subsection is brief as the focus of this report is on the empirical analysis and results. However, a more comprehensive literature review was produced as an interim report for this project (Meehan, Pacheco & Watson, 2020).

Demographic shifts

Although demographic trends are not often explicitly considered under the future-of-work umbrella, they are an important overarching factor that has potentially important implications for WHS. Four main demographic considerations that are relevant in the NZ context are: the ageing population, increased workforce participation of women, growth in migration and the high rates of workplace harm among certain population groups, particularly Māori and Pasifika.

Like most other countries, NZ's population and workforce are ageing. NZ's median age has increased from 27.9 years in 1980 to 37.3 in 2015 and is projected to increase to 43.7 by 2050 (United Nations, 2019). The workforce is also ageing as the flow of young people entering the workforce slows and more people are working for longer. While NZ is following general global trends on this front, it is worth recognising that its population remains somewhat younger than other OECD countries - the average median age across OECD countries in 2015 was 40.0 versus NZ's 37.3 years. This provides the opportunity to examine what is occurring in other countries that have an older population structure to identify and learn from emerging age-related issues.

Although there is conflicting evidence in the international literature, the majority of research suggests that an ageing workforce will increase work-related injuries. Additionally, several studies find that older workers suffer more severe injuries than younger workers, resulting in more time off work due to injury (Berecki-Gisolf et al., 2012; Farrow and Reynolds, 2012; Personick and Windau, 1995; Rogers and Waiatrowski, 2005, Smith and Berecki-Gisolf, 2014; Salminen, 2004).

Turning to gender considerations, more women are working with female labour force participation in NZ increasing from 55% in 1987 to 66% in 2019 (New Zealand Productivity Commission, 2019). While women have a much lower work-related injury claim rate than men, international research suggests that these gender differences are largely due to differences in industry and occupation (e.g. Smith & Mustard, 2004).

Recent decades have also seen high levels of net migration into NZ. The number of permanent long-term gross migrant arrivals in recent years has been approximately double the number of NZ residents reaching 15 years old, the age that they may legally enter the workforce (New Zealand Productivity

Commission, 2019). Furthermore, the last four years (prior to the Covid-19 border restrictions) coincided with the highest level of net migration for the past 40 years (New Zealand Productivity Commission, 2019). These patterns are important as international evidence points to migrant workers having higher rates of workplace injuries relative to native-born workers (e.g. Schenker, 2010). A variety of explanations could account for these differences. For example, a range of papers have shown that migrant workers are over-represented in more dangerous industries and occupations (Ahonen et al., 2007; Reid, 2010; Schenker, 2010; Vartia-Väänänen & Pahkin, 2007). However, Schenker (2010) finds that even within occupational categories, migrants have a higher injury rate relative to their native-born counterparts.

NZ's situation is potentially somewhat different than that of many countries as immigration policy focuses on the intake of skilled migrants (Bedford, 2006; Maani & Chen, 2012). This results in a higher relative education level among the migrant population than in many other countries (OECD, 2018). Theoretically, this should provide a protective effect for health and safety risks among migrant workers in NZ, and may mean that migrant workers are less likely to work in high-risk industries/occupations than in other countries. However, international evidence from Canada, which has a similar skilled migration policy, suggests this may not be the case in practice. Smith and Mustard (2008) find that migrant men who have been in Canada for less than five years have twice the rate of work-related injuries as Canadian-born men. However, they find no difference in injury risk between migrant and Canadian-born women.

Of final consideration under the umbrella of demographic shifts are the stark differences by ethnicity in work-related injury claim rates in NZ. They are 103 per 1,000 FTEs for Māori, compared with 100 for Pacific; 83 for Europeans; and 63 for Asian. 'Other' ethnicities, who account for only a small share of the population (less than 3%), have by far the highest injury rate (207) (Chen, 2018). As discussed in the context of age and gender, the higher injury rates for particular ethnicities may be because they are over-represented in high-risk industries and occupations. The multivariate regression analysis that will be presented in Section 4.2 should shed more light on this possibility.

Effectively addressing these ethnicity gaps is important in itself, but is even more crucial given the Government's responsibilities towards Māori under the Treaty of Waitangi. To this end, WorkSafe's Maruiti 2025 sets out a strategy to reduce fatalities, serious harm, and health impacts on Māori in the workplace. In addition, Puataunofo Come Home Safely initiative is an education programme that delivers tailored health and safety messages to Pasifika workers in English, Samoan, and Tongan, through workplace sessions facilitated by WorkSafe inspectors.

Changing industry mix

There are vast differences in the prevalence of work-related harm across industries (discussed in more detail in Section 4). Consequently, industry mix dynamics will have implications for WHS. In NZ, as in other OECD countries, the share of employment in relatively low-risk industries has generally been increasing. The past decade has seen the share of employment in the primary (agriculture and mining) and goods (manufacturing, construction and utilities) sectors continue to decline, while the share of employment in the services sector has been rising. These trends are most evident via a drop in the percentage of the workforce employed in manufacturing (falling from 25.3% in 1976 to 9.8% in 2013); a corresponding rise in health and education (increasing from 12.5% and 19.3%); and an increase in the proportion in the professional services sector (increasing from 2.6% to 9.7%) (New Zealand Productivity Commission, 2019). This highlights that even in the absence of improving WHS conditions, overall workplace harm is likely to decrease over time due to changes in the economy's industrial composition.

The international evidence highlights differences in WHS risks by industry and that changes in industry mix alter the aggregate risk profile for a country. In general, increased automation and the transformation from operational roles to monitoring and problem-solving ones introduces risks of more physical inactivity and musculoskeletal strain, while reducing other risks and hazards such as repetitive stress and other injuries associated with the factory floor (Hauke, Flaspöler & Reinert, 2020).

These industry differences highlight that while shifts away from high-risk industries will bring improvements to WHS outcomes overall, they still bring challenges. There is a need to shift attention and resources to addressing issues that are prevalent within growth industries, such as musculoskeletal strain and psychosocial risks. Yet, at the same time, there is a need to continue working to reduce harm in traditionally high-risk industries like forestry. This presents a challenge given resource constraints.

The rise of non-standard work?

The future of work is associated with changes in workplace practices. Some of these have been facilitated by technological progress, such as digitalisation, giving rise to platform work. Some involve workplace practices to improve the productivity or wellbeing of workers. There has already been a recognition in NZ and other countries that the traditional work model of full-time permanent work and a simple employer-employee relationship does not sufficiently cover the spectrum of modern work models. In particular, following the Australian model, NZ's HSWA 2015 has moved from an employer-employee dichotomy to use of the broader concepts of a 'Person Conducting a Business or Undertaking (PCBU)' and 'Workers' to capture all types of modern working arrangements.

However, as workplace arrangements move away from the traditional employer-employee relationship, WHS becomes inherently more difficult to manage. Moreover, practices within workplaces, even traditional ones, are becoming more varied as employers increasingly offer flexible working arrangements to boost productivity, attract talent and improve worker wellbeing. These trends also make WHS more difficult to manage.

While there are data limitations, it appears that the extent of non-standard work in NZ remains low and does not show signs of growing (New Zealand Productivity Commission, 2019). Nevertheless, it is important to consider what potential WHS issues non-standard work may bring, particularly as the international literature highlights that non-standard employment is associated with higher workplace harm (e.g. Breslin & Smith, 2006; Grabell et al., 2013; Lippel et al., 2011; Quinlan et al., 2009; Quinlan et al., 2001; Smith et al., 2010; Underhill & Quinlan, 2011).

New organisational work practices

So-called new (‘innovative’ or ‘flexible’) practices encompass flexible work (e.g. teleworking, flexi-time), management practices and work organisation (e.g. total quality management, just-in-time, team work, job rotation), incentive structures (e.g. performance-based pay) and much more. These practices have a variety of aims, such as increasing employee work-life balance and wellbeing, increasing flexibility for the firm and/or workers, boosting firm productivity and profitability, and so forth.

Recently, Covid-19 has necessitated an increase in the use of some of these work practices, particularly teleworking. While borne out of necessity, this appears to have been a catalyst for some workplaces to implement these practices more broadly, leading to an acceleration in the pace of adoption of flexible work arrangements in particular.

Because new organisational work practices are diverse, it is difficult to generalise the consequences for WHS outcomes. However, the literature suggests that many such practices may have unintended negative consequences for WHS (Kaminski, 2001), while some practices may be associated with better WHS outcomes, at least in some dimensions. Practices aimed at creating high-performance workplaces and increasing the ability for employers to modify employees’ hours are generally associated with worse WHS outcomes (e.g. Askenazy, 2001; Robinson & Smallman, 2006; Askenazy & Caroli, 2010). However, employee-directed flexibility, such as the option to choose to work from home, may improve workers’ wellbeing (e.g. Costa et al., 2006).

Technological progress

Technological changes affect all aspects of work, from who or what performs particular tasks, how and where tasks are performed and ways in which work is organised. The development, use and communication of digital information has facilitated trends such as the 'virtualisation' of work, leading to more teleworking, for example.

A big advantage for WHS of technological advances is the ability to remove workers from hazardous situations. For example, automation and robotics are also being increasingly used in high injury and fatality sectors, for example, in the forestry sector to fell trees (Axelsson, 1998; WorkSafe, 2016). It can also reduce worker exposure to relatively low-level risks, for example, by reducing the number of workers undertaking repetitive tasks. However, new, albeit often lower-level, risks can also emerge. For example, from increased human-machine interfaces, including ergonomic risks that can lead to musculoskeletal injuries (ILO, 2019).

3 Data and descriptive statistics

We use linked administrative and survey data available in Stats NZ's Integrated Data Infrastructure (IDI) and Longitudinal Business Database (LBD). These databases provide a rich set of population-level unit record information on individuals and businesses. This includes a census of all ACC injury claims, which we use to construct our workplace safety outcome variables. It also means that we can link information on workers, which is available in the IDI, with information on their workplaces, which is available in the LBD, via the Linked Employer-Employee Database (LEED). This allows us to include explanatory variables on both the characteristics of individuals as well as the characteristics of the businesses they work in. This provides measures of many of the future-of-work variables that are discussed above. This section describes how we constructed our research dataset, details the outcome and explanatory variables used and provides some basic summary statistics.

3.1 Creating the data spine

A first step is to create our data spine. This defines our population of interest, which is based on employee-level Inland Revenue (IR) data. We use workers with observed monthly PAYE 'wage and salary' income information for 2018 from the IR Employer Monthly Schedule (EMS).[1] The rationale for using monthly observations is that we want to link workers with their workplaces in order to examine the relationship between WHS outcomes and their characteristics as well as those of their workplaces. Since some workers change jobs during the year, and, indeed, some jobs are seasonal, monthly individual-level observations allow for a more accurate linking between workers and their workplaces, and the associated injury claims, compared to annual data.

One limitation of our spine is that it does not include self-employed workers unless they pay themselves a wage/salary. While the IDI does contain self-employed income information (other than self-employed wage/salary earnings), it is generally only available on an annual basis, making it more difficult to accurately link workers and their workplaces in a time-consistent way as with monthly wage/salary data.

As a first step in data cleaning, we create individual-month observations. While this is unproblematic in the vast majority of cases, issues arise for the small number of individuals who worked for more than one employer in a given month. In these cases, we assign the individual to one employer based on which job

[1] As will be discussed below, 2018 was chosen because it matches with the timing of the Business Operations Survey 2018 (BOS2018), where we will draw relevant firm-level variables on business practices from.

was their main source of income according to their tax code, or, if both jobs have the same tax code (for instance, because the worker changes employers during the month), the job with the highest income (noting that the data does not include information on hours paid). In this way, all individuals are assigned to a unique employer for each month that they have wage and salary income recorded in the EMS.[2] At this stage we also add to our dataset the firm-level information relating to that employer associated with each individual-month observation.

Returning to our spine dataset, we in fact use two spine datasets: one which includes a greater set of firm-level explanatory variables but which is restricted to workers employed by firms with six or more workers, and one which includes fewer explanatory variables but full coverage of the firm-size distribution. Firms (and their employees) are only included in these two spine datasets if they have valid information on a set of basic firm-level information in the LBD.[3] Additionally, we exclude firms (and their employees) who have a zero rolling-mean-employment count in the Business Register data.

The first spine dataset (the '**BOS sample**') includes all individual-month observations in the IR 2018 for which the employer has valid information within the Business Operations Survey (BOS) sample. BOS covers a sample of firms with six or more employees, which amounts to approximately 13% of all firms with six or more employees in the LBD.[4] Therefore, while the inclusion of firm-level variables from BOS means that workers in small firms will be excluded, as will be discussed below, it allows the analysis to include a wider set of relevant variables on firm characteristics and firms' use of future-of-work practices.

The second spine dataset (the '**full sample**') includes the same employee-month observations as the BOS sample, but with the addition of workers from small firms with less than six employees. These small firms were chosen based on a random sample of 13% of all small firms with less than six employees. This was done for consistency with the size of the BOS sample (13% of firms with six or more employees).

Overall, the full sample dataset has over eight million individual-month observations relating to over 914,000 individuals.[5] Firms with six or more employees account for about a third of the firms in the dataset, while they represent 96% of individual-month observations.

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[2] Nevertheless, we also record a binary indicator for whether the individual holds multiple jobs in a given month, to be used in our data analysis as we might risk assigning later WHS outcomes to the wrong employer by this simplification. We checked the robustness of our estimates with respect to this risk by excluding individuals with multiple payments in a month and the results did not change.

[3] This involved dropping only a small number of firms who did not have basic information, such as industry, firm age and rolling-mean employment.

[4] Firms who are in BOS based on a rolling-mean-employment count of six or more at the time of the survey sample was selected, but have an actual rolling-mean-employment count of less than six in the LBF 2018 are dropped in order to ensure consistency.

[5] Although our sample consists of 13% of all firms, it contains more than 13% of all employees as very large firms are overrepresented in the unweighted BOS sample and we are not able to consider the BOS firm-weights in our employee sample.

3.2 Workplace safety outcome variables

Our outcome measures of interest are physical work-related injuries from ACC injury claims data. ACC data are an extremely rich source of work-related injury information. These data not only provide information on the incidence of work-related injury claims that can be linked to the characteristics of the individual and the firm/s they work in via the IDI and LBD, they also provide indication of injury severity. These measures include the amount of medical fees incurred and the number of compensation days paid to the claimant for time taken off work due to injury (see Table 1). These measures have been used by researchers previously and the strengths and limitations of the data are well documented (in particular see Poland, 2018).

We consider the universe of ACC claims made in 2018 to match the availability of data on firms' future-of-work practices from the BOS 2018 Module C on the 'Changing nature of work'. We use only those ACC claims which are accepted and tagged as being work-related. Work-related injuries are defined as all injuries that occur while a person is at work in NZ. It does not include injuries to: bystanders (such as customers), unpaid workers and volunteers, workers commuting to and from work, workers as a result of intentional self-harm or workers resulting from natural causes.

Not only is it an advantage to have the universe of accident claims linked to other administrative and survey data to provide a rich set of information on workers and their workplaces, there are distinct features of NZ's ACC system which mitigate under- and mis-reporting concerns, at least in principle. ACC is a compulsory universal, no-fault system, which should minimise underreporting issues relative to other jurisdictions (however, in practice, there appears to still be some underreporting – see 'Data limitations' below). In addition, the earnings compensation entitlement is the same whether or not an injury is work-related, whereas in other countries earnings compensation is typically only available for work-related injuries. This should minimise the incentives to misreport non-work accidents as being work-related.

Since the ACC data lacks a unique incident identifier, we follow the approach of Poland (2018) and assume that if an individual has multiple claims with the same incident date that these relate to the same accident. The issue effects a very small proportion of claims in our dataset (less than 1%). Poland (2018) suggests that multiple claims with the same accident date likely arise because multiple providers submit a payment claim for injuries relating to the same incident. In line with Poland (2018), we keep only the details of the claim with the highest associated medical costs in these cases.

We collapse the claims data from ACC to the individual-month level in order to connect it to the individual-month observations in the spine dataset. The vast majority of individuals have none or only one accident per month. In the small number of cases where an individual has more than one work-related accident in a given month, we create the outcome variables of interest by summing across all accidents to create variables on the medical costs to date and number of compensation days.

Looking at the full sample of about eight million individual-month observations after these data cleaning steps, 56,502 or 0.7% had at least one work-related ACC claim (Table 1). Looking at all ACC claims (not just work-related ones) as a reference point, 3.2% had at least one claim. Around 90% of individuals who have at least one ACC claim in 2018 had only one claim, while only around 1% have three claims or more. The average medical costs for work-related ACC claims in our dataset is $905.12. Most claims involved medical costs only, with only about 15% also involving compensated time off work. For those who had compensated time off work, the average number of days taken was about 6.6 (Table 1).

Table 1 Outcome variables: Work-related physical injuries based on ACC claims data

Variable	Definition	Mean
Any work-related injury claim	A dummy variable equal to one if the worker had at least one work-related injury claim during the month; zero otherwise.	0.7%
Total medical costs of all work-related injury claims	Sum of the medical costs to date for all work-related injury claims that occurred in that month.	$905.12
Any compensated days off work	A dummy variable equal to one if the claim involved any compensated time off work; zero otherwise.	15.27%
Number of compensated days off work due to work-related injury	Count of all the compensated days off work taken to date for work-related injury claims that occurred in that month (includes claims with zero compensation days).	6.64 days
Number of individual-month observations		8,025,291
Number of individuals		914,274

Data limitations

As discussed, the universal, no-fault nature of the ACC system and the ability to access earnings compensation whether an accident is work-related or not should minimise underreporting and misreporting issues. In practice, however, there does appear to still be a reasonable amount of underreporting. Poland (2018) estimates that about a third of those who report having an injury that stops them from doing their usual activities for more than a week do not appear to have received any form of accident compensation (including treatment costs). This number is similar to international estimates but is surprisingly high given that ACC is a simple and universal claims system where treatment providers, rather than the injured individual, submit treatment claims.

In addition, when interpreting the results presented in Section 4, it is also important to note that previous research has found that the degree of underreporting varies by age and ethnicity, likely reflecting differences in attitudes and access to healthcare treatment (Poland, 2018). Relative to NZ Europeans, people of Chinese ethnicity who reported having a limiting injury were 29 percentage points less likely to have an accepted ACC claim and Māori were 12 percentage points less likely. For those who had a limiting injury, the likelihood of having an ACC claim decreases with age. Moreover, those in more physical or dangerous occupations who had an injury were more likely to have an ACC claim, likely because injuries have more of an impact on their ability to work. Therefore, some differences in work-related injury claims are likely to reflect a combination of differences in actual injury rates and differences in the propensity to seek medical treatment in the event of an injury.

Similarly, differences in injury severity measures across different groups of workers are likely to reflect a combination of actual differences in severity and differences in the amount of medical treatment and compensation days claimed. For example, an office worker will require less time off work for a lower limb fracture, say, than a construction worker. Access to healthcare also tends to vary across groups. This could be because of lack of convenient access to medical providers (for example, due to living in a rural area or lacking transport) and/or cost reasons. Since injury treatment, such as physiotherapy, often involves a user co-payment, some groups are less likely to receive their full injury treatment entitlement. As an example of these kind of disparities, the NZ Health Survey finds that Māori and Pacific adults are more likely to be unable to visit a GP or fill a prescription due to cost than non-Māori and non-Pacific adults respectively.

3.3 Explanatory variables: Individual-level variables

The above outcome measures can be related to a number of individual characteristics, available through the IDI, and employer characteristics, available through the LBD. As mentioned, the IDI and LBD are linked through LEED, which allows us to identify which individuals are employed by which firms. This subsection discusses the individual-level variables used and the next subsection looks at the firm-level variables.

Linked administrative data available through the IDI provide measures of a number of individual-level characteristics, such as age, gender, ethnicity, migration status and earnings. We focus on individual-level information that is available for the entire population via administrative data. We do not draw individual-level information from survey data because some of the key firm-level future-of-work variables will be drawn from survey data (specifically, the BOS 2018) and it is not possible to undertake robust analysis using survey sources from within both the IDI and LBD. This is because there would be very little overlap between the survey samples and the resulting sample would also likely be unrepresentative of the underlying population. Given that we can only use one survey and this project is primarily concerned with future-of-work trends, we have therefore chosen to use the BOS 2018 survey and restrict attention in the

IDI to population-wide administrative information on individuals in terms of explanatory variables. This inability to use multiple linked surveys means that we cannot include some individual-level characteristics that are not available via administrative data sources but are available via surveys, such as occupation, hours worked and highest qualification (discussed further in 'Data limitations').

The individual-level variables employed in our empirical analysis are presented in Table 2. Consistent with higher employment rates among men, 56% of the over eight million individual-month observations in the full sample dataset relate to men. About 14% of observations relate to workers aged 15-24 years, 24% to those aged 25-34, 20% to those aged 25-44, about 15% to those aged 55-64 and 5% to those aged 65 and over.

About 55% of observations relate to workers of European ethnicity, 17% Asian, 15% Māori and 9% Pacific Peoples. The share of non-Europeans is relatively high for two reasons. First, the IDI personal details table uses an 'ever recorded' definition of ethnicity. This means that a person is assigned to the Māori ethnicity group, for example, if they identify as Māori in any contributing data source (birth registrations, Ministry of Education, Ministry of Health, ACC etc.) at any time. This inflates the share of those with multiple ethnicities compared with using a single source, such as the Census. However, it is the only source of ethnicity data in the IDI that covers the entire population of interest. Moreover, in order to assign each individual to only one ethnicity to facilitate regression analysis, we use a prioritised ethnicity definition (consistent with Stats NZ's pre-2006 approach). An individual who identifies as Māori and any other ethnicity is recorded as Māori; an individual who identifies as Pasifika and any other ethnicity other than Māori is recorded as Pasifika; and so forth, with the order of prioritisation being: Māori, Pacific Peoples, Asian, MELAA[6], Other, European. That is, someone is recorded as European only if they are never recorded as having any other ethnicity. Over 60% of the individual-month observations relate to people who were born in NZ.

The average monthly gross earnings from the individual's main job is just under $5,500. About 5% hold multiple jobs within a given month. About 9% started a new job (i.e. changed employers or went from not being employed to being employed) in a given month. The average amount of time an individual has been with their current employer is 56 months.

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[6] Middle Eastern, Latin American, African.

Table 2 Individual-level explanatory variables: Definitions and characteristics (full sample)

Variable	Definition	IDI source	Category	Mean
Female	Dummy equal to one if identified as female; zero otherwise.	Personal details		0.44
Age	Set of dummy variables equal to one if the individual's age is within of the following age groups, and zero otherwise. Underlying continuous age is as at 30 June 2018 and is calculated based on the month and year of birth (day of birth is unavailable in the IDI).	Personal details	15-24	0.14
			25-34	0.24
			35-44	0.20
			45-54	0.21
			55-64	0.15
			65 and over	0.05
Ethnicity	Set of dummy variables equal to one if *prioritised ethnicity* was identified as being one of the following ethnicities, and zero if European only: Māori, Pacific Peoples, Asian, MELAA, Other. *Prioritised ethnicity* - Respondents are allocated a single ethnicity where the order of priority is in accordance with the list above.	Personal details	Māori	0.15
			Pacific Peoples	0.09
			Asian	0.17
			MELAA	0.02
			Other	0.02
			European	0.55
Born in NZ	Dummy variable equal to one if born in NZ, i.e. observed in DIA birth records; zero otherwise.	Department of Internal Affairs - Birth records		0.62
Multiple jobs	Dummy variable equal to one if observed to receive earnings from more than one employer in the respective month; zero otherwise.	IR data		0.05
New employer	Dummy variable equal to one if changed employers during the month. This can involve a change in employer or a move from not being employed to being employed. We cannot observe if individuals changed jobs/roles within a business, and therefore did not switch employers.	IR data		0.09
Job tenure	Number of continuous months that the individual has been employed by the same firm.	IR data		55.98 months
Monthly gross earnings	Gross wages/salaries from the main job (sum of all payments by one employer) in respective month. *Main job* is defined as the job with the main / highest source of income based on tax code M (or equivalent). If no job or multiple jobs have the tax code M, the job with the highest income is assumed to be the main job.	IR data		$5,469.23
Number of individual-month observations				**8,025,291**

Data limitations

As discussed, our individual-level explanatory variables are restricted to information available on a population-wide basis from administrative sources since our firm-level information includes survey data. Therefore, a major limitation is that there is no information on hours worked or paid.[7] This means that it is not possible to investigate, for example, whether a lower work-related injury rate among women is partly driven by lower exposure due to lower work hours, nor whether part-time workers have higher injury rates once exposure time is controlled for.

Unfortunately, information on employment type (such as permanent, fixed term, casual etc.) is also not available at the population-level. However, as will be discussed in Section 3.4, firm-level information on the share of workers on different types of employment contracts is available. Further, while we have information on industry, it would be desirable to also look at occupation.[8] For instance, an accountant and a truck driver may both be employed by the same transport company and therefore will be recorded under the transport, storage & warehousing industry, but their occupations have very different injury risk profiles.

In addition, while we have created a variable for whether the individual was born in NZ based on birth registrations, we do not have population-level information on when those who were not born in NZ first resided in NZ. This means we cannot investigate, for example, whether the workplace safety outcomes of recent immigrants differ from those of long-term immigrants.

We also do not have information on highest qualification. While qualification information is available via Ministry of Education administrative data in the IDI, this is restricted to NZ qualifications gained since 2004 for secondary education and 1994 for tertiary education. Thus, the coverage of this information is not comprehensive, and will be particularly poor for certain groups, such as older workers and migrants.

It is worth noting that the Census includes some of this information that is not available through administrative sources. However, even though the Census covers the whole population of those present in NZ on census night, we do not use the Census here. The Census 2013 is now outdated and does not

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[7] IRD taxable income information does not include hours worked or paid. Fabling & Maré (2015) propose an algorithm for addressing the absence of hours information in the IDI, which we could potentially use to identify part-time versus full-time workers. However, it should be noted that this measure has limitations. For example, it assumes that workers must be paid at least the statutory minimum wage and adjusts the hours worked accordingly. However, HLFS data suggests that a reasonable minority of workers are indeed paid below the minimum wage. Moreover, this adjustment will be biased towards individuals with lower earnings – for instance, an individual with annual earnings of $80,000 will not be subject to an hours adjustment even though she may be only working three days a week. Therefore, it is not clear that it is better to make this adjustment or be transparent about the fact that the analysis does not attempt to control for hours worked or paid.

[8] Indeed, there is a lack of information on the nature of a worker's role within a business more generally. This means, for example, that we cannot include explanatory variables that may be relevant to workplace safety outcomes such as how physical a worker's job is.

include important groups, such as migrants who arrived in NZ after March 2013. The Census 2018 is also problematic as it has a non-response rate that is relatively high and non-random. This means that certain groups are underrepresented in Census 2018, such as Māori and individuals who live in higher deprivation areas. Furthermore, several variables of interest, such as occupation, have been deemed of poor quality in Census 2018 by the external data quality panel (see Stats NZ, 2019).

3.4 Explanatory variables: Firm-level variables

As discussed, the LBD linked to the IDI via LEED allows us to identify the characteristics of the firms that individuals work in. Some of these variables are drawn from administrative data that are available for all firms. However, many are drawn from the BOS 2018. As explained above, we therefore use two samples: one covering workers from firms across the firm-size distribution but which necessitates a limited set of explanatory variables, and another that covers workers in firms with six or more employees only but which allows for the inclusion of a wider set of explanatory variables drawn from BOS 2018. In particular, BOS 2018 includes a one-off module on the 'Changing nature of work' which has relevant information for the future of work, such as the use of automation and modern workplace practices.

The Longitudinal Business Frame & Employer-Employee Tax Data

The Longitudinal Business Frame (LBF) and Employer-Employee Tax Data provide general information for all firms on characteristics such as the number of employees and industry. Table 3 provides definitions, LBD sources and summary statistics for these firm-level variables. Recall that the full sample includes a random sample of smaller firms (with less than six employees) and larger firms (with six or more employees) who are sampled in BOS 2018. The average size, as measured by the rolling-mean-employment number, of the small firms is about 2.3 versus 108.1 for the large firms in the dataset.[9] In line with expectations, the larger firms are also older on average (19.2 years versus 11.6 years for small firms). The smaller firms are more likely to be in the agricultural and construction industries, and less likely to be in manufacturing, information media and telecommunications, and financial and insurance services. Larger firms also have a higher average overseas ownership rate (13.3% versus 1.2%).

[9] This number is high compared with the median size of firms with six or more employees in our spine dataset, and also compared with other sources such as Stats NZ Business Demographic Statistics. This is because very large firms are overrepresented in the unweighted BOS sample and we are not able to consider the BOS firm-weights in our employee sample.

Table 3 Firm-level LBF explanatory variables: Definitions and characteristics of firms

Variable	Definition	Category	Small firms (mean)	Large firms (mean)
Firm size	Twelve month moving average of the enterprises' monthly employment count.		2.33	108.1
Firm age	Age of the business on 30 March 2018 based on the birth date of the business.		11.61	19.17
Industry	Set of dummy variables equal to one if business is in one of the 18 ANZSIC level 1 industry categories; zero otherwise.	Agriculture, Forestry & Fishing	0.16	0.09
		Mining	S	0.01
		Manufacturing	0.06	0.21
		Electricity, Gas, Water & Waste Services	S	0.02
		Construction	0.17	0.06
		Wholesale Trade	0.05	0.08
		Retail Trade	0.09	0.05
		Accommodation and Food Services	0.07	0.04
		Transport, Postal & Warehousing	0.03	0.04
		Information Media & Telecommunications	0.01	0.03
		Financial & Insurance Services	0.02	0.05
		Rental, Hiring & Real Estate Services	0.04	0.02
		Professional, Scientific & Technical Services	0.11	0.1
		Administration & Support Services	0.04	0.06
		Education & Training	0.01	0.03
		Health Care & Social Assistance	0.04	0.06
		Arts & Recreation Services	0.01	0.02
		Other Services	0.07	0.03
Overseas ownership rate	Share of the enterprise which is owned by overseas persons or firms; zero if no overseas shareholders.		1.17	13.3
Firm profit (amount)	Annual gross profits for those firms with available information.		$66.37	$4,243.61
Number of firms			**12,555**	**6,456**

Note: All variables are sourced from Business Register data from the LBF. 'S' indicates the number has been suppressed in accordance with Stats NZ confidentiality rules. Small firms: Less than 6 employees. Large firms: 6 or more employees.

The Business Operations Survey

While the LBF and Employer-Employee Tax data provide firm demographic information for the full sample of firms, the BOS provides more information on workplace practices for firms with six or more employees. In particular, the BOS 2018 'Changing nature of work' module collected information on workplace practices, such as flexible work provisions, and other aspects relevant to the future of work, such as the firm's level of automation.

Table 4 provides variable definitions and some key summary statistics from BOS. The average firm reports that 80% of its employees work full time (30 hours or more a week). In addition, the average firm reports that about 80% of employees are on permanent employment contracts, 11% on casual contracts and about 5% on fixed-term contracts

Over 60% of businesses reported that health and safety considerations had influenced whether changes were made to how the business was run in the last two years to a moderate or great degree. A further 23% said it had a small amount of influence, while 11% of businesses said it had no influence at all.

In terms of business practices, many businesses offer flexible working arrangements, such as the option of part-time work (57%), flexi-hours (61%) and working from home (35%). The vast majority (90%) of businesses have employee participation in WHS. However, it is somewhat surprising that this is not higher given worker participation is required under the Health and Safety at Work Act 2015.

The degree of automation of physical tasks is measured on a scale ranging from zero (no automation) and 4 (full automation of both routine and non-routine physical tasks). The average degree of physical task automation is 0.42.

Data limitations

A caveat of the BOS data is that it is a representative sample of NZ private enterprises with six or more employees. Therefore, BOS does not provide information on small firms, nor on public sector and not-for-profit organisations. The responses are also self-reported, and often in a yes/no format, and thereby do not provide a sense of how and to what extent these policies and practices are implemented within the firm. For example, while two businesses may both respond that they offer working from home arrangements, one business may allow their employees to use this freely while another may require it to be pre-arranged and formally signed off by a manager. In addition, the relevant questions in the 'Changing nature of work' module were only asked in BOS 2018, so unfortunately no time series data are available on these variables.

Table 4 Firm-level BOS variables: Definitions and characteristics of firms (BOS sample)

Variable	Definition	Category	Mean
Automation			
Physical task automation	Scale of the degree of automation in the business's routine and non-routine physical tasks. For routine and non-routine physical tasks, the scale assigns a score between 0 (none) and 2 (fully) and sums the two scales to give a score that ranges from 0 to 4 (from no automation of routine and non-routine physical tasks to full automation of both routine and non-routine physical tasks).		0.42
New automation of physical tasks	Dummy for whether the business introduced any new automation which was most significant to routine or non-routine physical tasks (only asked of businesses who introduced any new automation in the last 2 years).		0.08
Flexible working arrangements			
Part-time work option	Dummy for whether the business provides part-time work options.		0.57
Job sharing option	Dummy for whether the business provides job sharing options.		0.20
Shift work option	Dummy for whether the business provides shift work options.		0.28
Flexi-time option	Dummy for whether the business provides options for flexible start and finish times.		0.61
Work from home option	Dummy for whether the business provides options to work from home.		0.35
Share of employees...			
...in full-time employment	Share of employees in full-time positions (30 hours or more a week).		0.80
...in management & professional positions	Share of employees in managerial or professional positions.		0.20
... on different contract types	Share of the firm's workers employed on different contract types.	Permanent	0.80
		Fixed-term	0.05
		Casual	0.11
		Contract for services	0.04
...covered by collective employment agreement	Set of dummies for the share of employees covered by a collective employment agreement.	None	0.71
		1-10%	0.05
		11-50%	0.05
		51-90%	0.04
		91-100%	0.11

Table 4 Firm-level BOS variables: Definitions and characteristics of firms (BOS sample) Continued

Variable	Definition	Category	Mean
Firm structure			
Utilised the gig / sharing economy	Dummy for whether the business utilised the gig or sharing economy to provide goods or services to customers in the last 2 financial years.		0.02
Identifies as a Māori business	Dummy for whether enterprise considers itself to be a Māori business.		0.04
Mergers and acquisitions	Dummy for whether the business merged with or acquired a shareholding in another business in the last financial year.		0.04
Assets			
Equipment age	Set of dummies for how the business's core equipment compares with the best commonly available technology.	Fully up to date	0.45
		Up to 4 years behind	0.27
		4-10 years behind	0.1
		> 10 years behind	0.03
		Don't know	0.15
Health & safety and recruitment			
Health and safety influence	Set of dummies for the extent to which health and safety considerations have influenced whether changes have been made to how the business is run in the last 2 years.	Not at all	0.11
		A small amount	0.23
		A moderate amount	0.31
		A great deal	0.31
		Don't know	0.04
Recruitment difficulties	Set of dummies for the extent to which the business experienced recruitment difficulties in the past year.	None	0.14
		Moderate	0.41
		Severe	0.36
		Don't know	0.08
Market			
Market competition	Set of dummies for the self-assessed strength of the competition faced by the business.	Captive market / No effective competition	0.04
		1-2 competitors	0.17
		Many competitors, none dominant	0.16
		Many competitors, several dominant	0.59
		Don't know	0.05

Table 4 Firm-level BOS variables: Definitions and characteristics of firms (BOS sample) Continued

Variable	Definition	Category	Mean
Change in market share	Set of dummies for the change in the business's market share in the last year.	Decreased	0.08
		Stayed the same	0.39
		Increased	0.27
		Don't know	0.26
Employee engagement			
Decision making	Dummy for whether the business has practices in place for employee engagement in regular decision making.		0.58
Health and safety	Dummy for whether the business has practices in place for employee participation in health and safety.		0.90
Feedback programmes	Dummy for whether the business has employee feedback programmes (e.g. satisfaction surveys)		0.52
Performance review	Dummy for whether business conducts performance reviews.		0.81
Training and mentoring programmes	Dummy for whether the business has training and mentoring programmes.		0.77
Policies & practices			
Pay gap policy	Dummy for whether the business has pay gap policies or practices in place.		0.22
Ageing workforce policy	Dummy for whether the business has ageing workforce policies or practices in place.		0.22
Bullying policy	Dummy for whether the business has bullying policies or practices in place.		0.67
Diversity and inclusion policy	Dummy for whether the business has diverse and inclusive workplace policies or practices in place.		0.47
Leave & childcare arrangements			
Buy extra annual leave / take unpaid leave	Dummy for whether the business allows employees to buy extra annual leave or take unpaid leave		0.61
Care leave	Dummy for whether the business allows employees to take sick, unpaid or compassionate care leave to care for other people who are sick.		0.71
Childcare allowance or facilities	Dummy for whether the business provides some sort of childcare allowance or facility.		0.09
Parental leave provision	Dummy for whether the business provides parental leave beyond statutory requirements.		0.19
Number of firms			**6,456**

Note: All variables in this table are sourced from BOS 2018, with the majority from Module C: 'Changing nature of work'.

4 Results: Work-related injury claims

This section presents results on the relationship between work-related injury claims, our main outcome of interest, and individual and firm characteristics. It provides descriptive, bivariate statistics on the relationship between the incidence of injuries, medical costs and compensation days for each of the explanatory variables separately. These results are consistent with previous statistics in this area – for example, men have more injuries than women. However, some of these results are likely to be driven by other differences, such as industry of work. Therefore, we then present multivariate regression results, which reveal that many of these bivariate relationships still hold, but some are mediated by other factors and, therefore, do not hold when these other factors are controlled for.

4.1 Bivariate relationships

For the individual-month observations in the full sample, Table 5 presents the share of observations with ACC work-related claims, the average medical costs of those claims, the share of those claims that involved compensated time off work, and the mean number of compensation days for these claims. It looks at these variables by key individual characteristics, such as gender, age and ethnicity, separately. That is, these are bivariate relationships only.

As noted above, 0.7% of individual-month observations in the full sample had an ACC work-related injury claim. The claim rate among men is much higher than among women (0.86 versus 0.51). In addition, when men have a work-related claim, the severity is greater with higher average medical costs ($975 versus $753) and a greater likelihood of taking compensated time off work (15.5% versus 14.8%). This is as expected, although, as mentioned, it is important to keep in mind that these are only bivariate relationships which do not control for factors such as differences in industry.

The bivariate relationship between ACC claims and age is not linear: the youngest workers and those aged 55-64 have relatively high claim rates. However, when young people do have accidents, the severity (as measured by average medical costs and compensation days) tends to be lower. Older workers not only have higher claim rates, the severity of their injuries is also relatively high. However, the claim rate among the oldest workers (65 and over) is relatively low, perhaps reflecting that those in this age group are less likely to be engaged in physical work and/or more likely to work part time. However, when they do have ACC claims, they have high associated medical costs and compensation days. As discussed above, it may be that these differences by age partly reflect differences in the propensity to make an ACC claim in the event of an injury, with previous research finding that a ten-year increase in age is associated with a decreased likelihood of having a claim by 2.5 percentage points (Poland, 2018).

Turning to ethnicity, Māori workers have relatively high claim rates (1.0%) and the severity of their injuries also tends to be high, with 18% of claims involving compensated time off work. Previous research has found that people of Māori ethnicity who have an injury are less likely to have an ACC claim than NZ Europeans (Poland, 2018), which suggests that the actual difference in injury rates may be even higher. While Pasifika workers also have relatively high claim rates (0.95%), the severity of their injuries is relatively low, with lower-than-average medical costs ($730) and compensated time off work (5.75 days). Asian workers have the lowest claim rate and injury severity, although based on previous research (Poland, 2018), this may be partly due to a lower propensity to file a claim in the event of injury. Europeans have below average claim rates, but these claims have the highest associated medical costs of all ethnicities. However, Europeans with claims have fewer compensation days. Those who were born in NZ have higher claim rates than those who were not born in NZ (0.74% versus 0.64%), as well as higher medical costs and compensation days in the event of a work-related injury. The multivariate analysis that will be presented below should shed some light on whether these differences reflect systematic differences by ethnicity in other factors such as industry of work.

As expected, those with multiple jobs have higher claim rates than those who have one job, but lower medical costs and compensation days. Those who started a job with a new employer during the month have higher claims rate, medical costs and share of claims with compensated time off work.

Workers who are employed by small firms (less than six employees) have higher claim rates than their counterparts in large firms (0.87% versus 0.70%) but a lower share of these claims involve compensated time off work (11.36% versus 15.48%). The multivariate analysis that will be presented below will shed some light on whether there are other factors mediating this bivariate relationship. For example, some relatively high-risk industries (such as agriculture and construction) also have a high share of small firms.

Indeed, industry differences are stark. Workers in the agriculture, forestry & fishing industry have the highest work-related injury claim rate (1.36%), followed by construction (1.11%) and other services (1.07%). Financial & insurance services (0.14%) and information media & telecommunications (0.16%) have the lowest claim rates. Perhaps surprisingly, mining has a relatively low claim rate (0.58%), but when workers in this industry do have accidents, they involve relatively high medical costs. Transport, postal and warehousing has a relatively high claim rate (0.88%) and injuries in this industry are the most severe, with the highest associated medical costs ($1,335), share of claims with compensation days (almost 21%) and number of compensation days (9.41). Although it is likely to be only a relatively small part of the story, some of these industry differences may reflect differences in propensity to make ACC claims rather than differences in actual injury rates. Those in the agriculture industry, for example, are more likely to be in a physical or dangerous role, and Poland (2018) finds that in the event of an injury, those in more physical or dangerous occupations have a greater propensity to have an ACC claim, possibly reflecting that an injury is more likely to impact on their ability to work than (say) an office worker.

The injury claim rate decreases as a worker's tenure with the same firm increases (0.89% for workers who have been with the firm for less than a year, versus 0.53% for those with a tenure of six years or more). However, the associated medical costs tend to increase with tenure. Since these are bivariate relationships only, the positive relationship between medical costs and tenure may be related to worker age since those with longer tenure also tend to be, on average, older. Indeed, the multivariate relationships that control for other factors including age that will be presented Section 4.2 suggest that both injury rates and severity decrease somewhat with tenure.

The injury claim rate is lowest among workers earning $6,500 or more a month and highest among those earning $3,000-$4,500 (0.39% versus 0.94%). Those earning less than $3,000 have a lower injury claim rate than those earning $3,000-4,000, possibly because there are more part-time workers in the lowest earnings group.

Table 5 Descriptives of ACC work-related claims by worker characteristics (full sample)

	ACC work-related claim	Medical costs average $	Earnings compensation	Compensation days
Groups	share (%)	mean	share (%)	mean
All	0.70	905.12	15.27	6.64
Gender				
Men	0.86	974.73	15.50	6.71
Women	0.51***	753.40***	14.77**	6.49
Age				
15-24	0.85***	516.60***	12.87***	4.78***
25-34	0.71	743.99***	14.99	5.73***
35-44	0.61***	957.88*	15.28	6.85
45-54	0.67***	1,078.65***	16.14***	7.61***
55-64	0.75***	1,252.67***	16.87***	8.30***
65 and over	0.65***	1,074.17***	16.59*	7.83***
Ethnicity				
Māori	1.00***	947.67	17.99***	7.92***
Pacific Peoples	0.95***	729.58***	14.23**	5.75***
Asian	0.51***	785.23***	14.13***	5.65***
MELAA	0.73	813.50	16.80	6.60
Other	0.71	907.68	14.49	5.89
European	0.64***	960.30***	14.62***	6.57
NZ Born				
Not NZ Born	0.64	839.30	0.14	5.97
NZ Born	0.74***	939.81***	0.16***	6.99***
Multiple jobs				
Has only one job	0.70	913.85	15.36	6.68
Has multiple jobs	0.79***	749.43***	13.67**	5.92*
New employer				
Stayed with same employer	0.68	916.69	15.16	6.64
Started job with new employer	0.91***	814.04**	16.12**	6.63
Job tenure				
Less than 1 year	0.89***	833.10***	15.77**	6.77
1-3 years	0.75***	923.05	15.37	6.66
3-6 years	0.64***	968.30**	15.08	6.73
6 years or more	0.53***	944.35	14.35***	6.34*
Monthly gross earnings				
Less than $3,000	0.73***	940.80	19.38***	8.41***
$3,000-$4,500	0.94***	844.75***	15.58	6.70
$4,500-$6,500	0.76***	929.91	13.75***	5.96***
$6,500 and over	0.39***	936.32	9.77***	4.48***
Firm size				
6+ employees)	0.70	903.43	15.48	6.68
< 6 employees)	0.87***	936.80	11.36***	5.91*

Table 5 Descriptives of ACC work-related claims by worker characteristics (full sample) Continued

	ACC work-related claim	Medical costs average $	Earnings compensation	Compensation days
Groups	share (%)	mean	share (%)	mean
Industry				
Agriculture, Forestry & Fishing	1.36***	924.16	13.79***	6.45
Mining	0.58***	1317.75**	16.86	6.97**
Manufacturing	0.95***	939.89	16.42***	6.97**
Electricity, Gas, Water & Waste Services	0.85***	861.03	14.27	6.41
Construction	1.11***	995.88**	15.45	6.78
Wholesale Trade	0.66***	846.56	14.04**	6.04*
Retail Trade	0.58***	668.67***	12.72***	5.16***
Accommodation and Food Services	0.61***	600.78***	12.04***	4.47***
Transport, Postal & Warehousing	0.88***	1,334.70***	20.96***	9.41***
Information Media & Telecommunications	0.16***	532.32**	S	2.29***
Financial & Insurance Services	0.14***	681.49**	7.81***	3.61***
Rental, Hiring & Real Estate Services	0.58***	671.70**	10.46***	4.16***
Professional, Scientific & Technical Services	0.20***	642.56***	8.41***	3.50***
Administration & Support Services	0.82***	720.03***	15.17	6.66
Education & Training	0.62***	625.97***	10.59***	3.94***
Health Care & Social Assistance	0.61***	963.40	17.84***	8.15***
Arts & Recreation Services	0.59***	771.38	13.91	5.82
Other Services	1.07***	918.29	10.02***	4.79**
Number of individual-month observations				**8,025,291**

Notes: p-values: *, **, *** represent statistically significant differences at the 10%, 5% and 1% levels respectively. For binary categorical variables (e.g., men/women), the p-value refers to differences between the given category and the base category. For multi-level categorical variables (e.g., ethnicity, industry, etc.), the p-value refers to differences between the given category and all other categories combined. Medical costs are the average costs for all claims for the worker in a given month. Earnings compensation share is the percentage of claims where time was taken off work. Compensation days is the average number of days taken off work for all claims – that is, claims with no compensation days are counted as zeros in the mean.

4.2 Multivariate regression analysis

Although the bivariate descriptive statistics provided in the last section present some interesting relationships between individual- and firm-level characteristics and work-related injuries, these do not account for mediating factors. For example, the higher injury rate among young workers may, in fact be driven by their shorter average job tenure. Therefore, this section reports conditional associations using multivariate regression analysis.

Methodology

We estimate the conditional associations between individual and firm characteristics and workplace injuries using linear estimation models (OLS). In some cases, this means abstracting from the binary nature of the outcome variable in order to simplify the estimation process given computational power limits and the large size of our datasets.[10] As mentioned, we only have cross-sectional data available on many of the firm-level characteristics. Therefore, our empirical analysis is restricted with respect to the ability to draw causal inferences from our results. We are not able to explore dynamic associations to identify whether a particular individual or firm characteristic causes better or worse WHS outcomes.

Specifically, we estimate equations of the type:

$$P(ACC_{\mathrm{ift}}) = \alpha + \beta_1 I_{\mathrm{it}} + \beta_2 \mathrm{IR}_{it} + \beta_3 F_f + \beta_4 BOS_f + \epsilon_{it}$$

$$Med.Costs_{\mathrm{ift}} \mid (ACC_{\mathrm{ift}} = 1) = (\alpha + \beta_1 I_{\mathrm{it}} + \beta_2 \mathrm{IR}_{it} + \beta_3 F_f + \beta_4 BOS_f + \epsilon_{it} \mid (ACC_{\mathrm{ift}} = 1))$$

$$Comp.Days_{\mathrm{ift}} \mid (ACC_{\mathrm{ift}} = 1) = (\alpha + \beta_1 I_{\mathrm{it}} + \beta_2 \mathrm{IR}_{it} + \beta_3 F_f + \beta_4 BOS_f + \epsilon_{it} \mid (ACC_{\mathrm{ift}} = 1))$$

ACC_{ift} is an indicator of whether individual *i* working in firm *f* had at least one ACC claim in month *t*. $Med.Costs_{\mathrm{ift}}$ are the medical costs and $Comp.Days_{\mathrm{ift}}$ are the days of earnings compensation associated with a claim if it occurs ($ACC_{\mathrm{ift}} = 1$).[11]

The set of explanatory variables includes vectors for individual socio-demographic characteristics (I_i) (such as gender, age and ethnicity) and a vector for individual economic characteristics from the IR data (IR_{it}), as described in Table 2 (such as job tenure, gross monthly earnings, multiple jobs held and an

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[10] The results have nevertheless been checked for their sensitivity with respect to the method choice. Models with binary outcome variables, such as the occurrence of a ACC claim, have been re-estimated using a standard limited dependent variable framework (logit estimation) as well as a rare events logistic regression framework in order to take into account that only 0.7% of individual-month observations have an associated ACC claim. Average marginal effects based on these estimated coefficients as well as the significance levels are very much in line with the estimates of the linear estimations.

[11] We considered the use of a selection model in order to estimate regressions of injury severity that take account of the selection into an injury claim. However, in order to obtain reliable coefficient estimates, a Heckman selection model typically requires an exclusion restriction. It is difficult to establish a credible exclusion restriction variable that influences selection into having an injury claim but is not related to the error term in the medical costs (or compensation days) equation.

indicator for a change in employer). It also includes a vector for general firm-level characteristics from the LBD (F_f) as described in Table 3 (such as ANZSIC06 industry classification, firm size, firm age, overseas ownership rate and firm profits) and a vector for workplace practices and other more specific firm-level information from the BOS data (BOS_f) as described in Table 4.

To account for the serial correlation of standard errors, these are clustered on the individual- or firm-level depending on the specification. Cluster levels are reported in relevant tables.

Results: Work-related injury claims rate

Table 6 presents the regression results for the binary outcome variable of any work-related ACC claim. The specification includes the full set of variables, including BOS variables, and is therefore restricted to firms with six or more employees.[12] Column 1 presents the results for all individuals, while Columns 2 and 3 restricts attention to male and female workers respectively, allowing for the possibility of coefficient heterogeneity. Many of the bivariate relationships discussed above hold in general, but with some important differences, particularly with respect to age.

Gender and age

Women are approximately 0.29 percentage points less likely to have work-related ACC claims than men, even after controlling for other factors such as industry. This means that, for example, if women's employment rates increased from the current 44% so that they accounted for half of the employee-month observations, the overall injury claim rate would reduce from the current 0.7% to 0.68%, all else held constant. While this is a small change per se, each of these incremental changes in injury claim rates due to future-of-work factors could have a potentially sizeable cumulative effect. However, the gender differences are likely to be overestimated since we cannot control for occupation, and it is likely that some of these measured gender differences in injury claim rates even after controlling for factors such as industry are due to occupational differences. It may also be that the gender differences in injury claim rates decrease over time as occupations which have traditionally been dominated by one gender continue to move towards a more even gender mix.

This gender difference appears to contrast with evidence from Canada that lower workplace harm among women can largely be attributed to differences in industry and occupation (Smith & Mustard, 2004). However, while we have controlled for industry, because information on hours worked and occupation

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[12] The regression results for the sample including all firms but with a more limited set of variables is provided in Table A.1 and provides qualitatively similar results.

are not available at the population-level in the IDI, we cannot assess whether the remaining gender differences are due to a greater prevalence of part-time work and/or less physical work among women.

The multivariate regression results reveal quite different patterns for age than the bivariate findings discussed above (that younger and older workers have relatively high injury claim rates). After controlling for other factors, workers aged 45-54 years actually are 0.079 percentage points more likely to have a claim than the comparison group of 15-24 year olds, and those aged 55-64 are 0.125 percentage points more likely to have a claim. There is no statistically significant difference between 35-44 year olds and the comparison group of 15-24 year olds, and similarly for workers aged 65 and over. The generally positive relationship between work-related injury claim rates and age suggests that the ageing population may pose challenges for workplace safety going forward, although the magnitude of the coefficients is small. If the workforce aged so that the share of employee months accounted for by the age groups of 15-24, 25-34, 35-44, 45-54, 55-64 and 65 and over changed from the current 14%, 24%, 20%, 21%, 15% and 5% respectively to 10%, 17%, 20%, 25% 20% and 8%, based on the estimated coefficient, the injury claim rate could increase from 0.7% to 0.71% (all else held constant).

To investigate the differences between the bivariate and multivariate results further, Appendix Table A.1 presents the stepwise inclusion of control variables in the full sample dataset. This suggests that job tenure mediates the age results. That is, the higher injury claim rate among young workers in the bivariate results appears to be driven by their shorter average job tenure rather than their age per se. As with gender, it is possible that a greater prevalence of part-time work among young workers (particularly for those aged 15-24, many of whom may be students with part-time jobs), could also influence the results, but unfortunately, we are unable to control for hours of work. Moreover, the higher injury claim rates among older workers may be underestimated given the finding of Poland (2018) that suggests underreporting is more prevalent among older people. The lack in a statistically significant difference between the comparison group of 15-24 year olds and those aged 65 and over is, on the surface, unexpected, but may be due to unobservable factors, such as occupation.

Ethnicity and birthplace

The ethnicity results seen in the bivariate relationships hold in the multivariate regressions, suggesting that any mitigating effect of industry and other measurable factors is, at most, partial. Māori workers are 0.176 percentage points more likely to have an injury claim than European workers, and Pasifika workers are 0.12 percentage points more likely. Asian workers are 0.168 percentage points less likely to have an injury claim than European workers. Again, we cannot assess whether the remaining differences are due to systematic differences in occupation. Also, as discussed in Section 4.1, these differences by ethnicity may partly reflect systematic differences in the propensity to seek treatment in the event of an injury.

These differences would suggest that the Māori-European gap may be underestimated and the Asian-European gap may be overestimated given the higher propensity among Europeans to have an ACC claim in the event of an injury.

Higher fertility rates among Māori and Pasifika mean that their share of the NZ population is projected to increase (Statistics NZ, 2015). Consequently, it is expected that the share of Māori and Pacific Peoples in the workforce will increase over time. As an example, based on the regression estimates, if the share of individual-month observations accounted for by workers of Māori ethnicity increased from 15% to 20%, the share of Pacific Peoples increased from 9% to 15% and the share of Europeans decreased from 55% to 44%, the injury claim rate would increase from 0.7% to 0.72% (all else held constant). As discussed in the case of gender and age, the inability to control for occupation likely means that these ethnicity differences are somewhat overstated, and may decrease as diversity within occupational categories increases.

There are some interesting differences between the ethnicity results for male and female workers. The ethnic differences for females are, in general, less stark than those for men. Māori are more likely to have higher work-related injury claim rates than Europeans in both the male and female regressions and the coefficients are of similar magnitude (0.167 and 0.162 percentage points respectively). However, the difference between European and Pasifika women is only weakly statistically significant and of smaller magnitude than the difference between European and Pasifika men (0.134 percentage points for Pasifika men and 0.051 percentage points for Pasifika women). Similarly, while Asian females are 0.099 percentage points less likely to have an injury claim than European women, the magnitude of this difference is much smaller than between Asian and European men (0.219 percentage points). While industry is controlled for, these gender differences could reflect that ethnic differences in occupations are greater for men than women, with more Māori and Pasifika men working in physical and higher-risk occupations, such as construction labourers.

There are no statistically significant differences in injury claim rates between those who were and were not born in NZ. The international literature finds that migrant workers have higher rates of work-related injuries than native-born workers (Schenker, 2010). Several papers show this is because migrant workers are over-represented in more dangerous industries and occupations (Ahonen et al., 2007; Reid, 2010; Schenker, 2010; Vartia-Väänänen & Pahkin, 2007). However, even within occupational categories, migrants have been found to have higher injury rate (Schenker, 2010). NZ's situation is potentially somewhat different than that of many countries as immigration policy focuses on the intake of skilled migrants (Bedford, 2006; Maani & Chen, 2012). This results in a higher relative education level among the migrant population than in many other countries (OECD, 2018). This is likely to provide a protective effect for health and safety risks among migrant workers in NZ and may also mean that migrant workers are less likely to work in high-risk industries/occupations in NZ than in other countries. However, international evidence from overseas countries with similar skilled migration policies suggests this may not be the case in practice. For example, Smith and Mustard (2008) finds that migrant men who had been in Canada for less than five years experienced twice the rate of work-related injuries relative to Canadian-born men. They also find no difference in injury risk between migrant and Canadian-born women. Unfortunately, we do not have information on the amount of time migrants have lived in NZ so cannot investigate the possibility that results would be different for recent migrants versus those who have been in NZ for several years. It may also be possible that migrants in NZ have a lower propensity to have an ACC claim in the event of an injury as they may be less familiar with how the accident compensation system works. However, Poland (2018) finds no statistically significant difference in the propensity of those who were and were not born in NZ to make an ACC claim in the event of a limiting injury. However, Poland (2018)'s analysis largely excludes recent migrants due to the longitudinal nature of the survey data used, and therefore this does not entirely rule out the possibility that recent migrants have a lower propensity to make an injury claim in the event of an injury.

Job tenure

The injury claim rate decreases with job tenure, which is in line with expectations and consistent with international evidence (for example, Breslin & Smith, 2006; Morassaei et al., 2013). Recalling that tenure is based on length of time with the same employer, relative to those with tenure of under a year, those who have a tenure of 1-3 years are 0.082 percentage points less likely to have an injury claim, those who have a tenure of 3-6 years are 0.169 percentage points less likely, and those who have a tenure greater than six years or more are 0.27 percentage points less likely. New employee-employer relationships are also associated with higher injury claim rates. While it may be that those who switch employers often are different in general from those who do not switch as often, it could also reflect that those who stay longer with an employer have more experience in their role and a better handle on safety risks. However, since we cannot control for the nature of workers' jobs, it could also partly reflect that as employees stay longer with an employer, they change roles, and tend move to less physical roles over time (for example, by shifting from front-line to management roles).

The magnitude of the coefficients on tenure are larger for men suggesting a stronger association between injuries and tenure. For example, men who have tenure of six years or more are 0.349 percentage points less likely to have an injury claim, while women with this tenure length are 0.169 percentage points less likely.

Future-of-work trends such as non-standard work and technological change can increase the rate of job switching and therefore reduce job tenure (New Zealand Productivity Commission, 2019). However, in NZ, the rate of job switching does not appear to have increased over the past two decades (Coleman & Zheng, 2020). The rate was stable between 2000 and 2007, fell slightly between 2008 and 2012 following the global financial crisis, and then recovered to pre-recession rates between 2012 and 2017. It is usual that job switching (particularly voluntary job changes) will decrease during downturns as people seek security in their current employment and there are fewer outside opportunities to pursue. Therefore, although not examined, it is likely that the rate of job switching decreased in 2020 due to the Covid-19 lockdowns and border restrictions. However, looking to the longer term, if the trend of the last two decades of little change in the rate of job switching continues, then this will have few implications for workplace safety outcomes. Moreover, a reduction in job tenure of a reasonable magnitude would not lead to a large shift in injury claim rates based on the regression results presented. If the share of workers with job tenure of less than 1 year, 1-3 years, 3-6 years and 6 years or more changed from 26%, 26%, 19% and 28% respectively to 32%, 32%, 15% and 21%, the injury claim rate would increase to 0.72 (all else equal).

Income

Compared with workers earning less than $3,000 a month, those earning above $6,500 are 0.254 percentage points less likely to have an injury claim. This is as expected, and given that we cannot control for occupation, income may be acting as a partial proxy for this, with higher-paid management staff (for example) tending to face lower injury risk than lower-paid frontline workers. However, injury claim rates do not increase monotonically with earnings as those earning $3,000-$4,500 a month are 0.181 percentage points more likely to have an injury claim than those earning less than $3,000. However, this could be because those earning less than $3,000 are more likely to work part time, and, as discussed, we cannot quantify this possibility.

Industry

The injury patterns by industry are largely as expected and consistent with the bivariate results. Compared with the reference category of manufacturing, workers in the agriculture industry are 0.177 percentage points more likely to have an injury claim. Injury claim rates are lower than manufacturing in most service industries, such as wholesale trade (-0.248 percentage points), retail trade (-0.385 percentage points), accommodation & food services (-0.259 percentage points), financial & insurance services (-0.424 percentage points), information media & telecommunications (-0.467 percentage points) and so forth. This is as expected since these tend to be lower risk industries, with a smaller share of workers undertaking physical jobs. There is no statistically significant difference in injury claim rates between male workers in the construction industry and those in the manufacturing industry, and the likelihood of having an injury claim is lower for female workers in the construction industry compared with manufacturing industry workers. Workers in the mining industry are 0.332 percentage points less likely to have an injury claim than those in manufacturing. Although this seems surprising, it may be because mining is a very capital intensive industry, so perhaps only a relatively small share of workers in this industry are exposed to potentially hazardous situations. In fact, there are a very small number of workers in the mining industry in our sample, which suggests some caution in interpreting results for this industry is warranted. There is no statistically significant difference between transport, postal & warehousing and manufacturing. However, as discussed in Section 4.1 and Section 4.2.3 below, when accidents and injuries do occur in transport, postal & warehousing, they tend to be more severe.

The sizeable differences in injury claim rates by industry mean that changes in industry structure over time due to future-of-work trends could result in lower injury rates. As discussed in Section 2.2.2, there has been a shift of employment from agriculture and manufacturing industries to service industries, such as finance and insurance and professional services. If the share of employee-months accounted for by the agricultural industry were to decrease from 4% to 2%, and from 20% to 12% for manufacturing, and the share in ten of the service industries with low claim rates increased by one percentage point each, the overall injury claim rate would decrease from 0.7% to 0.66% (all else equal).[13] This is a reasonable (more than 5%) reduction, and are reasonably modest industry employment shifts relative to the large industry structure shifts NZ and other developed countries have experienced in recent decades (see Section 2.2.2).

In general, the industry differences for men are stronger than for women. Again, this may be because we cannot account for occupation – for example, risk factors such as the difference in the degree of physical work undertaken by women in different industries may be smaller on average than the across-industry differences for men.

Firm size and age

Turning to firm-level variables, there are no statistically significant differences in injury claim rates by firm size when all workers are examined together. The general view is that managing health and safety is more challenging for small firms who face resource constraints, less formal management styles and limited access to external support (for example, see MBIE, 2018). When the results are run separately for men and women, male workers in large firms with 250+ employees have a lower likelihood of an injury

[13] Note that the starting industry compositions used here are different than those presented in Table 3. This is because Table 3 presented firm-level industry shares, while these simulations are based on individual-month shares.

claim (-0.119 percentage points) compared with workers in firms with 6-49 employees, but the difference is only weakly statistically significant. For women, injury claim rates tend to increase with firm size. Female workers in firms with 50-249 employees are 0.08 percentage points more likely to have an injury claim than women in firms with 6-49 employees, and those in firms with 250+ employees are 0.141 percentage points more likely. Overall, consistent with previous research (Poland, 2017), the relationship between injury claims and firm size is not straightforward.

There are few differences in injury claim rates by firm age. For men, those who work in firms that are 5-9 years old are 0.161 percentage points less likely to have an injury claim than those who work in firms that are younger than five years. Those who work in firms that are 10-24 years old are 0.127 percentage points less likely to have an injury claim than those who work in firms that are less than five years old. There are no statistically significant differences by firm age for female workers. The few differences by firm age may reflect that most of the difference is captured by firm size given there is a positive correlation between firm age and firm size.

It is unclear what impact future-of-work trends might have on firm size and age. Innovation and rapid technological progress could see the number of small, young firms increase. However, digital technologies are also associated with "winner-takes-all" dynamics whereby one very large firm comes to dominate a market due to factors such as network effects. This may result in relatively more large firms. It is unclear whether and how these future-of-work trends are affecting the firm-size distribution within NZ. Moreover, even if the firm-size distribution changes, our coefficient estimates suggest that the impact of this on the injury claim rate would be small. For example, even if the share of employee-month observations accounted for by small firms (6-49 employees) doubled from 10% to 20%, and the share accounted for by medium and large firms decreased from 35% and 55% to 30% and 50% respectively, the injury claim rate would increase from 0.70% to 0.705%.

Automation

Workers in firms with higher levels of automation of physical tasks have lower injury claim rates. A one-point increase in the 0-4 degree-of-automation scale reduces the likelihood of having an injury claim by 0.08 percentage points for male workers. This is as expected and consistent with automation removing workers from potentially hazardous situations. However, there is no statistically significant difference for women, which may be because women are less likely to work in jobs with high injury risks and therefore benefit less from safety improvements due to automation. There is no statistically significant difference in injury claim rates for firms that have changed their degree of automation in the last two years.

While there are no NZ data available on changes in the level automation over time, this is a common future-of-work trend seen in other countries and it seems likely to also continue to increase in NZ. This is expected to reduce injury rates as automation, particularly of physical tasks, removes workers from potentially hazardous situations. An interesting example in NZ's case is forestry. To date, mechanisation and the use of cabbed machines with greater protection for operators in harvesting has reduced injuries and fatalities (WorkSafe, 2016). Going forward, the trend is towards further removing workers from high-risk situations via the use of autonomous machinery (Harrill et al., 2019).

Flexible working arrangements

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Firm share of employment type

The coefficient on the share of full-time workers in the firm is positive and significant for male workers but not female ones. A 10% increase in the share of full-time employees is associated with a 0.03 percentage point increase in the likelihood of having an injury claim for male workers.

As expected, workers in firms with a larger share of employees in management and professional positions have a lower claim rate. A 10% increase in the share of workers holding management or professional positions reduces the likelihood of having an injury claim by 0.03 percentage points. Similar to the case of the share of full-time employees, since we cannot control for occupation, this is likely to be a partial proxy for whether the worker is in a management or professional position, resulting in a negative coefficient. Again, the size of the coefficient for men is larger than for women. There is no statistically significant relationship between the share of casually-employed and contract-for-service workers.

Influence of health and safety consideration on the firm

BOS asked firms to assess the extent to which health and safety considerations have influenced whether changes have been made to how the business is run in the last two years. Workers in firms who responded 'A great deal' are 0.13 percentage points more likely to have an injury claim than those who work in firms that responded 'Not at all'. On the surface, this seems contradictory, but may simply reflect that firms with poorer safety records are more likely to have changed their practices in an effort to address these issues. Or that firms undertaking higher risk activities have higher injury claim rates and are also more likely to carefully monitor safety practices.

Employment engagement and voice

For the most part, there are no statistically significant differences between the injury claims rate for those who work in firms with various employment engagement practices and those who work in firms that do not have these practices. An exception is men who work in firms with employee feedback programmes (e.g. satisfaction surveys) are 0.097 percentage points less likely to have an injury claim than men who work in firms which do not have these programmes.

For men, relative to the base case of no employees being covered by collective agreements, workers in firms where 11-90% of workers are covered are 0.188 percentage points less likely to have an injury claim. There are no statistically significant differences by collective agreement coverage for women. Male workers in firms with employee feedback programmes also have lower injury claim rates. These variables likely reflect the amount of voice and bargaining power employees have within the firm, suggesting that greater voice reduces injury claim rates, at least for male workers. For women, having policies or practices to address pay gaps (including gender pay gaps) is associated with lower injury claims, however the result is not statistically significant for men. Female workers in firms that report having childcare allowances or facilities have a claim rate that is 0.076 percentage points higher than female workers in firms that do not report having these childcare arrangements.

Table 6 Regression estimates, ACC work-related injury claims (BOS sample, full specification)

	All	Men	Women
	b/se (1)	b/se (2)	b/se (3)
Female	-0.288*** (0.017)		
Age (Ref.: 15-24 years)			
25-34 years	0.014 (0.016)	0.009 (0.023)	0.017 (0.017)
35-44 years	0.025 (0.018)	0.001 (0.026)	0.054** (0.019)
45-54 years	0.079*** (0.019)	0.026 (0.026)	0.147*** (0.021)
55-64 years	0.125*** (0.021)	0.100*** (0.030)	0.149*** (0.022)
65+ years	0.001 (0.025)	-0.038 (0.035)	0.036 (0.026)
Born in NZ	-0.010 (0.009)	-0.023 (0.014)	0.002 (0.011)
Ethnicity (Ref.: European)			
Māori	0.176*** (0.016)	0.167*** (0.022)	0.162*** (0.019)
Pacific Peoples	0.120*** (0.021)	0.134*** (0.030)	0.051* (0.023)
Asian	-0.168*** (0.016)	-0.219*** (0.021)	-0.099*** (0.016)
MELAA	0.013 (0.027)	-0.052 (0.039)	0.106** (0.036)
Other	0.037 (0.024)	0.047 (0.032)	0.030 (0.033)
Job tenure (Ref.: Less than 1 year)			
1-3 years	-0.082*** (0.014)	-0.118*** (0.019)	-0.046** (0.014)
3-6 years	-0.169*** (0.015)	-0.218*** (0.020)	-0.117*** (0.016)
6 years or more	-0.270*** (0.018)	-0.349*** (0.023)	-0.169*** (0.017)
Monthly gross earnings (Ref.: Less than $3,000)			
$3,000-4,500	0.181*** (0.014)	0.243*** (0.023)	0.116*** (0.014)
$4,500-6,500	0.015 (0.017)	0.034 (0.026)	-0.034 (0.018)
$6,500 and over	-0.254*** (0.021)	-0.282*** (0.030)	-0.145*** (0.018)
Other job-related			
Multiple jobs	0.012 (0.018)	-0.022 (0.027)	0.052* (0.021)
New employer	0.056*** (0.017)	0.070** (0.026)	0.039* (0.016)
Industry (Ref.: Manufacturing)			
Agriculture, Forestry & Fishing	0.177** (0.056)	0.132* (0.064)	0.253*** (0.064)
Mining	-0.332*** (0.070)	-0.383*** (0.073)	-0.231* (0.100)
Electricity, Gas, Water & Waste Services	0.034 (0.138)	0.148 (0.151)	-0.215* (0.102)
Construction	0.061 (0.049)	0.044 (0.050)	-0.248*** (0.048)
Wholesale Trade	-0.248*** (0.039)	-0.300*** (0.049)	-0.167*** (0.037)
Retail Trade	-0.385*** (0.043)	-0.559*** (0.057)	-0.154*** (0.044)
Accommodation & Food Services	-0.259*** (0.048)	-0.506*** (0.060)	-0.019 (0.044)
Transport, Postal & Warehousing	-0.082 (0.049)	-0.088 (0.057)	-0.059 (0.047)
Information Media & Telecommunications	-0.467*** (0.055)	-0.542*** (0.066)	-0.362*** (0.047)
Financial & Insurance Services	-0.424*** (0.050)	-0.501*** (0.069)	-0.340*** (0.041)
Rental, Hiring & Real Estate Services	-0.431*** (0.058)	-0.483*** (0.071)	-0.267*** (0.062)
Professional, Scientific & Technical Services	-0.389*** (0.038)	-0.508*** (0.046)	-0.217*** (0.044)
Administration & Support Services	-0.221*** (0.053)	-0.211** (0.068)	-0.181*** (0.046)
Education & Training	-0.282*** (0.083)	-0.485** (0.172)	-0.076 (0.059)

Table 6 Regression estimates, ACC work-related injury claims (BOS sample, full specification) Continued

	All	Men	Women
	b/se (1)	b/se (2)	b/se (3)
Industry (Ref.: Manufacturing) cont…			
Health Care & Social Assistance	-0.222*** (0.046)	-0.542*** (0.062)	-0.114** (0.042)
Arts & Recreation Services	-0.163 (0.087)	-0.173 (0.145)	-0.110 (0.060)
Other Services	0.070 (0.093)	0.073 (0.102)	-0.286** (0.101)
Firm size (Ref.: 6-49 employees)			
50-249 employees	0.010 (0.027)	-0.022 (0.036)	0.080*** (0.023)
250+ employees	-0.020 (0.037)	-0.119* (0.048)	0.141*** (0.033)
Firm age (Ref.: Less than 5 years)			
5-9 years	0.113* (0.044)	0.161** (0.055)	0.031 (0.037)
10-24 years	0.107* (0.045)	0.127* (0.056)	0.043 (0.038)
25-49 years	0.055 (0.047)	0.096 (0.058)	-0.012 (0.037)
50+ years	0.072 (0.054)	0.117 (0.064)	-0.002 (0.049)
Ownership, profit and automation			
Overseas ownership rate	-0.001*** (0.000)	-0.001*** (0.000)	-0.001** (0.000)
Firm profit (amount)	0.015 (0.014)	0.007 (0.019)	0.003 (0.009)
Firm profit (indicator)	-0.030 (0.031)	-0.015 (0.044)	-0.015 (0.027)
Automation of physical tasks	-0.074*** (0.022)	-0.080** (0.028)	-0.036 (0.018)
New automation of physical tasks	0.070 (0.040)	0.069 (0.050)	0.049 (0.039)
Flexible working arrangements			
Part-time work option	-0.117*** (0.028)	-0.153*** (0.035)	-0.029 (0.024)
Job sharing option	0.018 (0.024)	0.036 (0.032)	0.001 (0.020)
Shift work option	0.042 (0.025)	-0.001 (0.032)	0.110*** (0.021)
Flexi-time option	-0.074** (0.028)	-0.029 (0.036)	-0.132*** (0.028)
Work from home option	-0.145*** (0.026)	-0.210*** (0.033)	-0.043* (0.021)
Share of employees…			
…in full-time employment	0.002*** (0.000)	0.003*** (0.001)	0.001 (0.000)
…in management and professional positions	-0.003*** (0.001)	-0.004*** (0.001)	-0.002*** (0.000)
…in casual employment agreements	0.000 (0.001)	-0.000 (0.001)	0.001 (0.001)
…on service contracts	-0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)
Firm structure			
Utilised the gig / sharing economy	-0.098 (0.055)	-0.083 (0.066)	-0.116** (0.043)
Identifies as a Māori business	-0.012 (0.056)	-0.026 (0.064)	-0.006 (0.041)
Merger or shareholding acquired	-0.088* (0.038)	-0.081 (0.046)	-0.042 (0.029)
Equipment age (Ref.: Up to date)			
Up to 4 years behind	-0.008 (0.024)	0.009 (0.030)	-0.022 (0.020)
4-10 years behind	-0.035 (0.043)	-0.026 (0.052)	-0.045 (0.037)
More than 10 years behind	-0.140* (0.060)	-0.143 (0.076)	-0.100* (0.049)
Don’t know	-0.017 (0.027)	0.015 (0.033)	-0.051* (0.025)

Table 6 Regression estimates, ACC work-related injury claims (BOS sample, full specification) Continued

	All	Men	Women
	b/se (1)	b/se (2)	b/se (3)
Health and safety influence (Ref.: Not at all)			
A small amount	0.016 (0.035)	0.024 (0.049)	-0.012 (0.030)
A moderate amount	0.087* (0.037)	0.105* (0.049)	0.032 (0.032)
A great deal	0.130*** (0.035)	0.157** (0.048)	0.054 (0.030)
Don't know	0.139** (0.049)	0.208** (0.071)	0.023 (0.045)
Recruitment difficulties (Ref.: None)			
Moderate	0.007 (0.028)	0.002 (0.039)	-0.003 (0.025)
Severe	0.079* (0.031)	0.100* (0.042)	0.035 (0.028)
Don't know	-0.118* (0.048)	-0.078 (0.062)	-0.138*** (0.038)
Market competition (Ref.: Many competitors, several dominant)			
Captive Market / No effective competition	-0.101* (0.046)	-0.143* (0.069)	-0.038 (0.036)
1-2 competitors	0.014 (0.028)	-0.002 (0.035)	0.033 (0.026)
Many competitors, none dominant	-0.013 (0.031)	-0.020 (0.038)	-0.009 (0.027)
Don't know	0.109 (0.087)	0.075 (0.103)	0.189* (0.083)
Change in market share (Ref: Stayed the same)			
Decreased	0.001 (0.036)	0.009 (0.045)	-0.012 (0.030)
Increased	0.017 (0.025)	0.004 (0.032)	0.010 (0.021)
Don't know	-0.007 (0.026)	0.001 (0.034)	-0.044* (0.022)
Share of employees covered by collective agreements (Ref.: None)			
1-10%	-0.031 (0.036)	-0.040 (0.046)	-0.009 (0.029)
11-50%	-0.077* (0.034)	-0.126** (0.046)	-0. 045 (0.028)
51-90%	-0.127** (0.046)	-0.188** (0.060)	-0.029 (0.040)
91-100%	-0.012 (0.050)	-0.026 (0.069)	0.001 (0.041)
N/A	-0.097 (0.057)	-0.160* (0.068)	0.006 (0.049)
Employee engagement			
Decision making	0.028 (0.023)	0.057* (0.028)	0.001 (0.020)
Health and safety	0.065 (0.060)	0.013 (0.078)	0.066 (0.048)
Feedback programmes	-0.071** (0.026)	-0.097** (0.032)	-0.023 (0.027)
Performance reviews	-0.015 (0.041)	0.022 (0.043)	-0.059 (0.049)
Training and mentoring programmes	0.065 (0.037)	0.052 (0.050)	0.061 (0.031)
Policies and practices			
Pay gap policy	-0.044 (0.027)	-0.013 (0.035)	-0.078*** (0.022)
Ageing workforce policy	0.032 (0.025)	0.017 (0.031)	0.049* (0.022)
Bullying policy	-0.052 (0.031)	-0.064 (0.039)	-0.005 (0.030)
Diversity and inclusion policy	-0.037 (0.028)	-0.053 (0.037)	0.011 (0.026)

Table 6 Regression estimates, ACC work-related injury claims (BOS sample, full specification) Continued

	All	Men	Women
	b/se (1)	b/se (2)	b/se (3)
Leave and childcare arrangements			
Buy extra annual leave / unpaid leave	-0.003 (0.026)	0.002 (0.033)	-0.008 (0.022)
Care leave	0.016 (0.031)	0.029 (0.040)	0.006 (0.026)
Childcare allowance or facilities	0.090** (0.033)	0.074 (0.042)	0.076** (0.028)
Parental leave provision	-0.008 (0.027)	0.001 (0.034)	-0.042 (0.022)
Constant	1.128*** (0.085)	1.270*** (0.109)	0.577*** (0.076)
Cluster level	**firm**	**firm**	**firm**
Observations	**7,696,755**	**4,318,317**	**3,378,438**
Share	**0.697**	**0.844**	**0.509**
R^2	**0.00311**	**0.00380**	**0.00163**

Notes: b/se are the estimated beta coefficient and standard error respectively. p-values: *, **, *** represent statistically significant differences at the 10%, 5% and 1% levels respectively. Standard errors are clustered to account for serial correlation. Firms with missing profit information were assigned a profit value of zero and an indicator for missing profit information was also included.

Results: Injury severity measures

Table 7 presents results for regression estimates using the full sample for medical costs and the number of compensated days off work as measures of injury severity for those who have ACC claims.

In addition to having a lower incidence of injuries (discussed above), female workers who have work-related injury claims have lower medical costs (about $246 lower on average) and compensation days (about 1.2 fewer days on average) than male workers. As discussed, this may be at least partly due to factors we cannot control for such as differences in occupation.

As discussed above, the probability of having an injury claim is higher among those aged 45-64 than those aged 15-24 years, with no statistically significant difference between other age groups and 15-24 year olds. However, consistent with international evidence, for those who do have injuries, the severity tends to increase with age. All age groups have higher medical costs and number of compensation days than 15-24 year olds. For example, workers aged 55-64 years have, on average, medical costs that are $685 higher and 5.2 more compensated days off work than those aged 15-24. This reinforces the discussion made in relation to injury claim rates in Section 4.2.2 that the ageing population may pose further challenges for workplace safety going forward.

While Māori workers have higher injury claim rates than Europeans (see Section 4.2.2), when they do have an injury, there is no statistically significant difference in medical costs, but the number of compensation days is greater by an average of about 0.9 days. Again, unobserved factors such as occupation may play a role here – for example, Māori may be more likely to hold physical jobs and may, therefore, require a fuller recovery from a fractured leg say, than someone with a sedentary job. While Pasifika workers are more likely to have an injury claim than Europeans (see Section 4.2.2), those who do have a claim have lower medical costs ($179 lower on average) and compensation days (1.1 fewer days on average) than European workers. As discussed, Asian workers are less likely to have injury claims than Europeans, but there is no statistically significant difference in the associated medical costs and compensation days. As mentioned above, Poland (2018) finds differences by ethnicity in the propensity to have an ACC claim in the event of an injury. It is also possible that part of the differences by ethnicity in medical costs and compensation days reflect systematic differences in the awareness of entitlements, the extent of medical treatment accessed (for example, due to issues such as the cost of co-payments) and/or the willingness to take compensated days off work even in the event of an accepted ACC claim (see Section 3.2 'Data limitations'). There are no statistically significant differences in the injury severity measures for those born in NZ versus those who are not.

While injury claim rates decrease with job tenure (see Section 4.2.2), there are fewer differences in medical costs and compensated days off work. The only category that is statistically significantly different from job tenure of less than 12 months is a tenure of six years or more, which is associated with lower medical costs (on average $155 lower than those with job tenure of less than a year) and compensated days off work (on average, 1.34 fewer days). This contrasts with the positive bivariate relationship between medical costs and job tenure discussed in Section 4.1. It appears that other factors, particularly age, mediate the relationship between medical costs and job tenure. That is, job tenure and age are positively related and medical costs tend to increase with age, so once age is controlled for, the unexpected positive relationship between medical costs and job tenure no longer holds.

For those with injury claims, the associated medical costs and compensation days tend to decrease as earnings increase. The average medical costs of those earning $6,500 and more a month are about $346 lower than the costs of those earning less than $3,000, and they take about six fewer compensation days on average. Again, this could be because earnings are related to occupation, which is unobserved. Workers in higher paid, lower risk professional and managerial jobs, for example, would be expected to have lower injury claim rates and less severe injuries when these do occur. Furthermore, since their jobs are less physical, they require less recovery time and, thus, fewer compensation days before returning to work.

There are less statistically significant differences in the injury severity measures by industry than there were for the injury claim rates (see Section 4.2.2). However, some interesting patterns emerge. As expected, workers in service industries such as finance, administration and food service who have injuries have lower medical costs and compensated days off work than those in the manufacturing industry. As discussed above, workplace safety outcomes may improve even in the absence of any changes to the approach taken to workplace safety if employment continues to move towards industries with relatively low injury rates and severity. However, while there was no statistically significant difference in injury claim rates between the transport, postal & warehousing and manufacturing industries (see Section 4.2.2), the associated medical costs and compensated days off work are higher in transport, postal & warehousing. On average, medical costs in the event of an injury claim for workers in the transport, postal & warehousing industry are $372 higher than those for workers in the manufacturing industry. Similarly, the average number of compensation days for workers in the transport, postal & warehousing industry is 2.0 days greater than those for workers in the manufacturing industry. This likely reflects that when accidents do occur in the transportation, these are more likely to be comparatively severe road accidents.

The only statistically significant difference by firm size is that workers in firms with 250+ employees with injury claims have more compensated days off work than those in firms with five or less employees. Although highly speculative, this could be because workers in large firms are more willing to take compensation days, while workers in small firms may be less inclined to due to small firms having greater difficulties in covering unexpected absences.

Table 7 Regression estimates, medical costs and number of compensation days

Outcome	Medical costs ($)	Compensation days
	b/se	b/se
Female	-246.36*** (31.26)	-1.20*** (0.25)
Born in NZ	23.50 (42.89)	0.47 (0.25)
Age (Ref.: 15-24 years)		
25-34 years	301.91*** (32.97)	2.25*** (0.26)
35-44 years	546.92*** (44.85)	3.83*** (0.32)
45-54 years	685.45*** (49.85)	4.68*** (0.34)
55-64 years	841.99*** (56.24)	5.24*** (0.39)
65+ years	619.14*** (75.23)	4.20*** (0.59)
Ethnicity (Ref.: European)		
Māori	8.75 (37.54)	0.87** (0.29)
Pacific Peoples	-179.30*** (51.42)	-1.08** (0.39)
Asian	-85.54 (54.29)	-0.49 (0.35)
MELAA	-44.10 (93.97)	0.36 (0.66)
Other	-104.74 (85.18)	-0.88 (0.57)
Job tenure (Ref.: Less than 1 year)		
1-3 years	21.89 (37.31)	-0.09 (0.26)
3-6 years	-17.69 (46.35)	-0.38 (0.32)
6 years or more	-154.97** (47.89)	-1.34*** (0.32)
Monthly gross earnings (Ref.: Less than $3,000)		
$3,000-4,500	-235.64*** (41.15)	-2.70*** (0.30)
$4,500-6,500	-300.63*** (54.10)	-4.33*** (0.37)
$6,500 and over	-345.92*** (70.00)	-6.08*** (0.41)
Other Job-related		
Multiple jobs	-129.81* (51.93)	-1.46*** (0.41)
New employer	-38.953 (40.01)	-0.259 (0.29)
Industry (Ref.: Manufacturing)		
Agriculture, Forestry & Fishing	-41.77 (63.14)	-0.64 (0.59)
Mining	224.40 (229.27)	0.44 (1.36)
Electricity, Gas, Water & Waste Services	-158.85 (112.20)	-1.03 (0.93)
Construction	5.56 (65.64)	0.34 (0.60)
Wholesale Trade	-100.46 (66.73)	-0.84 (0.72)
Retail Trade	-265.22*** (70.62)	-2.68*** (0.51)
Accommodation & Food Services	-209.16** (77.18)	-2.75*** (0.82)
Transport, Postal & Warehousing	371.94*** (97.46)	2.04*** (0.60)
Information Media & Telecommunications	-315.74** (117.49)	-4.34*** (0.81)
Financial & Insurance Services	-77.29 (121.52)	-3.57*** (0.68)
Rental, Hiring & Real Estate Services	-280.20* (133.16)	-2.71** (0.85)
Professional, Scientific & Technical Services	-289.913*** (73.07)	-2.58*** (0.58)
Administration & Support Services	-241. 72*** (57.20)	-1.93** (0.62)
Education & Training	-268.55*** (69.94)	-3.99*** (0.82)

Table 7 Regression estimates, medical costs and number of compensation days Continued

Outcome	Medical costs ($)	Compensation days
	b/se	b/se
Industry (Ref.: Manufacturing)		
Health Care & Social Assistance	-22.57 (82.64)	-0.25 (0.79)
Arts & Recreation Services	-69.27 (119.45)	-0.80 (0.86)
Other Services	-62.40 (112.87)	-1.10 (0.76)
Firm size (Ref.: 5 or less employees)		
6-49 employees	31.51 (78.14)	0.04 (0.54)
50-249 employees	54.53 (68.69)	0.36 (0.49)
250+ employees	-10.65 (73.87)	2.70*** (0.61)
Firm age (Ref.: Less than 5 years)		
5-9 years	10.41 (51.72)	-0.43 (0.53)
10-24 years	50.80 (51.48)	-0.05 (0.59)
25-49 years	-36.10 (52.71)	-0.49 (0.60)
50+ years	14.17 (86.08)	-0.90 (0.82)
Ownership and profit		
Overseas Ownership Rate	-0.78 (0.58)	-0.01* (0.01)
Firm Profit (amount)	-69.01 (43.84)	0.24 (0.24)
Firm profit (indicator)	135.35 (73.09)	0.43 (0.49)
Constant	789.82*** (99.47)	6.76*** (0.79)
Cluster level	**firm**	**firm**
Observations	**56,502**	**56,502**

Notes: b/se are the estimated beta coefficient and standard error respectively. p-values: *, **, *** represent statistically significant differences at the 10%, 5% and 1% levels respectively. Standard errors are clustered to account for serial correlation. 'Compensation days' are the average number of days taken off work for all claims – that is, claims with no compensation days are counted as zeros in the mean.

4.3 Summary and discussion

Overall, the regression results on work-related injury claims and injury severity measures are largely in line with expectations and with the bivariate relationships. Men, workers of Māori and Pacific ethnicities, those who have been with their employer for a shorter time, lower-income earners and those in higher-risk industries such as agriculture have a higher likelihood of having a work-related injury claim. While overseas research and NZ policy discussion (e.g. Chen, 2018) has suggested that immigrants warrant particular attention due to their higher risk of workplace harm, we find no evidence of higher injury claim rates among foreign-born workers compared to NZ-born workers. However, due to data limitations, we are unable to rule out the possibility that the patterns differ for certain migrants, such as recent arrivals.

However, some of the results are not in line with the bivariate relationships, highlighting the importance of mediating factors. The bivariate relationships show that the work-related injury claim rate is highest among the youngest workers (aged 15-24 years) and older workers (aged 55-64). The multivariate regression results are quite different. Compared with 15-24 year olds, workers aged 45-64 have higher injury claim rates. It appears that the relationship between injury claim rates and age is confounded by job tenure. Injury claim rates decrease as job tenure increases and younger workers tend to have shorter job tenure. While the oldest workers (65 years and over) do not have statistically significantly higher injury claim rates than those aged 15-24, this may be due to factors that we cannot observe, particularly hours worked and occupation. The finding that injury severity tends to increase with age holds in both the bivariate and multivariate analysis.

The results relating to age are relevant to discussions about the implications of the ageing population for workplace safety outcomes. The positive relationship between work-related injuries and age is even stronger in the multivariate analysis than the bivariate numbers suggest. Moreover, the multivariate results confirm that injury severity tends to increase with age. Given data limitations, we cannot completely rule out the possibility that this is driven by the nature of the roles different groups of workers are undertaking. However, since it seems reasonable to assume that older workers are, in general, undertaking less physical roles than younger workers, this most likely reflects that older people are more likely to suffer injuries, and that the severity of these injuries is higher and the recovery time is longer. While NZ’s population is ageing, it is still relatively young compared with many OECD countries, and lessons can therefore be drawn from approaches to WHS in the face of an ageing population from other jurisdictions. However, there are features of NZ’s system that potentially present specific issues.

The OECD has highlighted that the NZ health system distinguishes between 1. Injury and occupation disease and 2. other illnesses. The OECD argues that this distinction creates a two-tiered health system where integrated health services and vocational rehabilitation support is prioritised for injury, through ACC, but not for illness (OECD, 2018). There are two related difficulties in the context of this distinction between illness and injury in NZ’s healthcare system, which have particularly relevant consequences in the context of an ageing population. First, illness and injury interact. Second, differentiating between a work and non-work illness is challenging. Although these issues are general ones, they are likely to be exacerbated as the workforce ages.

In terms of the interaction between illness and injury, the international evidence finds that those with poorer health and comorbidities have a higher likelihood of injury (Biddle & Roberts, 2003; Wren & Mason, 2010). In addition, it is difficult in practice to distinguish between work and non-work related illness as an illness may have multiple potential causes and it is often hard to establish a direct link between working conditions and an illness. ACC only covers recognised occupational diseases (i.e. work-related gradual process, disease or infection) where a causal link between the illness and the person's employment is established. ACC cover does not extend to diseases with multiple potential causes, even if one of these causes is work-related (Driscoll et al., 2004). Given generally poorer health and comorbidities are more likely to occur in older people, this relationship between illness and injury and the difficulty of illnesses that have multiple causes is likely to become increasingly relevant as the population ages.

Looking at variables that relate to future-of-work trends such as automation and flexible work practices, in general, most of these do not have a particularly strong relationship with injury claims. One exception is the firm's degree of automation of physical tasks, with higher automation associated with lower injury claims for male workers, but there is no statistically significant relationship for female workers. This highlights that technological advances are likely to have different consequences for different workers. For example, automation removes workers from potentially hazardous situations, but this is more likely to improve the outcomes for those with more physical roles. While this is positive as this involves improving the safety outcomes for a particularly high-risk group of workers, it also highlights that the traditional higher-level safety risks need to be increasingly managed alongside a growing prevalence of lower-level risks, such as musculoskeletal injuries as a greater share of workers undertake jobs that involve a low level of physical activity. In addition, although it appears to be less of a concern to date in NZ (for example, see New Zealand Productivity Commission, 2019), the displacement of workers due to automation, which is disproportionately impacting certain groups such as middle-aged, non-college-educated white men in countries like the US (Autor, 2010; Case & Deaton, 2020), raises issues of psychosocial risks.

It is also important to note that the fact that many of the future-of-work variables do not have particularly clear relationships with work-related injuries does not necessarily mean these are unimportant. This may, at least in part, be due to the nature of the data. For example, while BOS 2018 provides information on whether or not a firm has a policy or practice or place, it does not provide information on how this is implemented and how widely it is used. Moreover, the implications for workplace safety of these future-of-work practices may become more important as they become more commonplace.

In terms of the magnitude of the potential implications of the main variables that are significantly related to work-related injury claims, some are associated with a higher injury rate and some with a lower injury rate. Since older workers and Māori and Pacific workers have higher injury claim rates, it could be that the injury rate increases in the future as the workforce ages and the ethnic composition of the workforce shifts (assuming all equal is held constant). However, a rising share of female workers, increasing levels of automation and a shift towards lower-risk industries could mean the injury rate decreases in the future. However, based on the regression coefficient estimates, each of these changes may only result in a small change in the injury claim rate. Moreover, the positive and negative changes are largely offsetting. It may be that, on balance, these possible future trends will put downward pressure on the injury claim rate due to the larger estimated decrease that could result from changes in the industry composition and as automation becomes more widespread.

5 The Health and Safety at Work Act

As mentioned in Section 2.1, the Health and Safety at Work Act 2015 (HSWA) was a main component of a package of reforms to WHS policy in NZ following the Pike River disaster in 2012 and the 2013 Independent Taskforce on Workplace Health and Safety review. In this section, we investigate whether the work-related injury claim rate has changed since the introduction of HSWA.

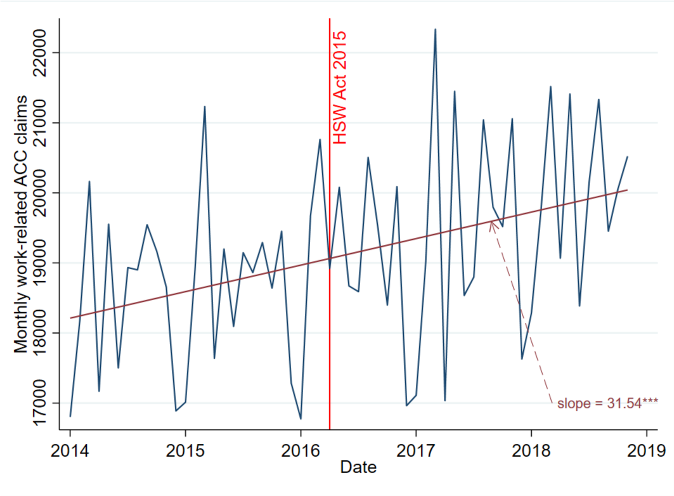
It is important to note, however, that it is not expected that the introduction of the HSWA would lead to a step change in the work-related injury claims rate. Instead, gradual changes over a period of time would be expected. Implementation is a gradual process as PCBUs (persons conducting a business or undertaking) make relevant adjustments, cases are tested in the courts, associated regulations are developed and further guidance and enforcement is implemented. However, the results are presented to highlight the importance of monitoring work-related harm trends going forward. It is also useful to note the difficulties this lack of sharp implementation presents in undertaking empirical analysis in an attempt to attribute any changes in injury claim rates to the HSWA (discussed more below).

Figure 1 shows the number of work-related ACC claims in aggregate and per 1,000 employees.[14] The graph shows the raw results and time trend which were estimated using linear estimations in order to remove the cyclical component. Overall, there has not been much change since the HSWA came into effect in April 2016. The count of work-related ACC claims has continued its upward trend (due to an overall increase in the workforce), while the number of ACC claims per 1,000 employees has decreased but this is a continuation of an existing trend and is very small in magnitude. Overall, as expected, there appears to be no stepwise change following the implementation of HSWA. As suggested, these results are perhaps unsurprising given the relatively short time since the HSWA has been implemented. Moreover, as acknowledged in the development of the Health and Safety at Work Strategy, there is still work to be done as while these changes provide a solid foundation, work continues towards implementing the regulatory reform programme (MBIE, 2018). Therefore, while it will be important to monitor work-related harm trends going forward, it may be too early to see the impact of the HSWA in the injury claim statistics.

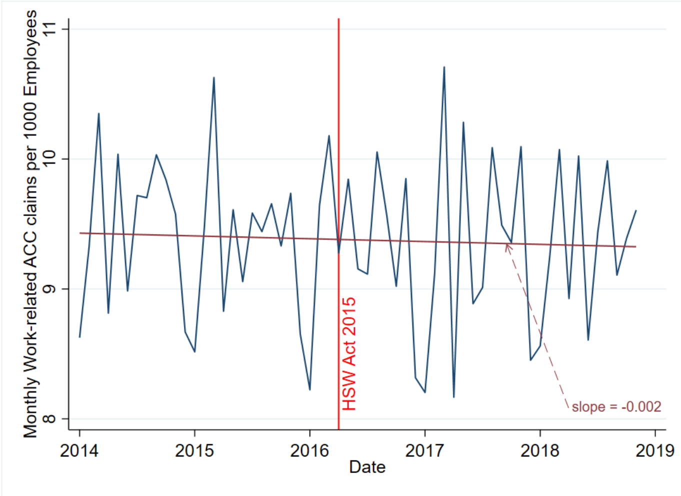
[14] All accepted work-related injury claims over time are included – that is, it is not restricted to claims for workers in our spine dataset.

Figure 1 Work-related injury claims, 2014-2018

A) Count of work-related injury claims



B1) Work-related injury claims per 1,000 employees



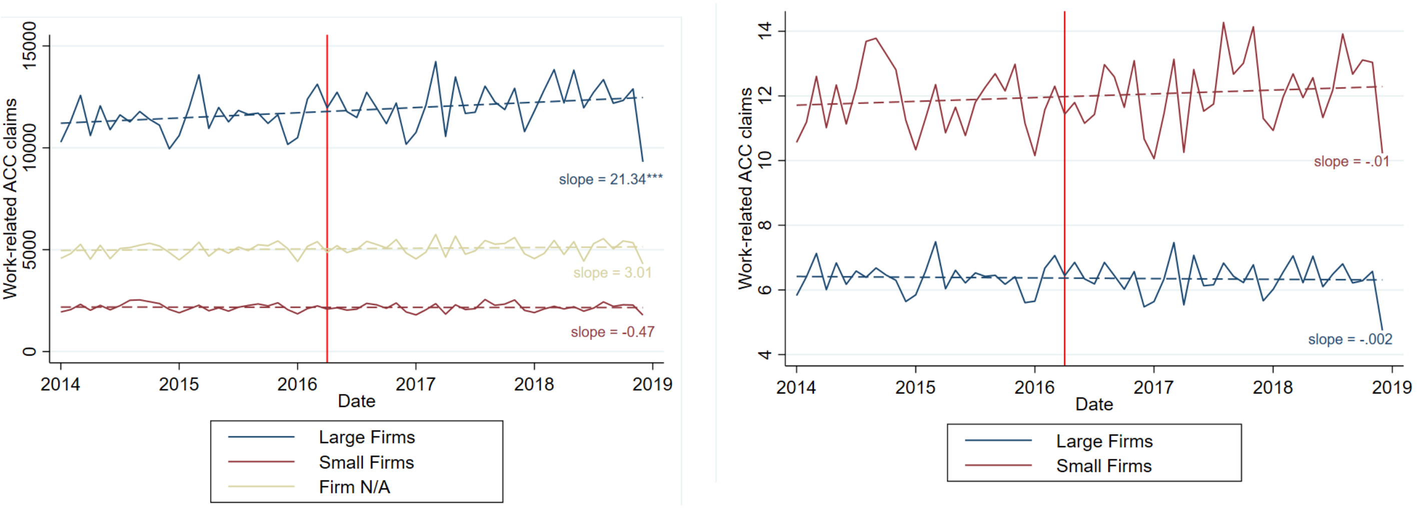
Notes: Trend graphs are produced using simple linear estimations. *, **, *** represent statistical significance at the 10%, 5% and 1% levels respectively.

It is possible that there were changes relating to only certain types of firms, particularly in terms of firm size, although given the discussion about the expectation of gradual changes above, this seems unlikely. Moreover, it is unclear what the theoretical expectation for this would be. For example, the HSWA may have presented a larger step-change for small businesses, but implementation and enforcement may have been stricter for larger firms. Figure 2 looks at the same trends as Figure 1 split into small (less than 6 employees) and large firms (6+ employees), there is no evidence of a step-change following the HSWA. The number of work-related ACC claims appears to have increased slightly for larger firms, and there was no perceptible change for small firms. ACC claims per 1,000 employees have been on a slight upwards trend for small firms, and was quite steady for large firms.

Figure 2 Work-related injury claims by firm size, 2014-2018

A) Count of work-related injury claims

B) Work-related injury claims per 1,000 employees



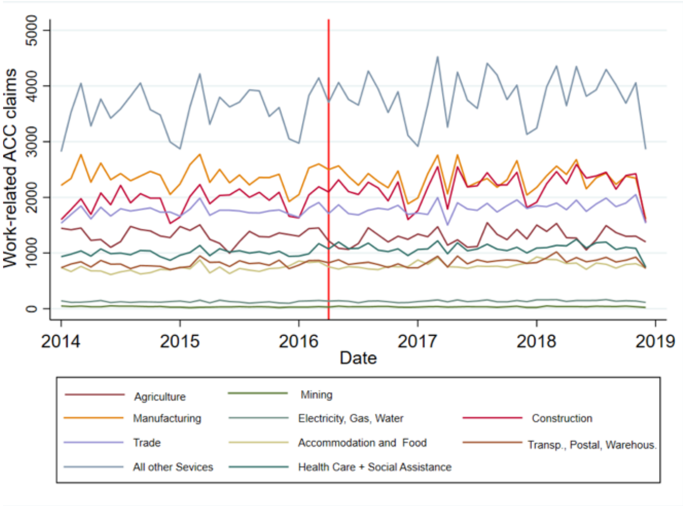
Notes: Trend graphs are produced using simple linear estimations. 'Large firms' refer to those with 6 or more employees; 'Small firms' refer to those with less than 6 employees. 'Firm N/A' refers to work-related injury claims for which no associated firm ID is available. These firms are not included in panel B because the lack of a firm identifer means we cannot identify firm characteristics, including the rolling-mean-employee count. *, **, *** represent statistical significance at the 10%, 5% and 1% levels respectively.

As discussed, even in the absence of actual improvements, work-related injury claim rates could change due to changes in industry structure, such as a structural change away from high-risk industries. We therefore also look at individual industries. Again, there are no clear trends in the number of injury claims nor in the number of claims per 1,000 employees. For presentational reasons, several service industries have been aggregated into one category labelled 'All other services'. There is an increasing number of work-related injury claims for this aggregated service industry. However, this likely reflects growth in employment in service industries as this increasing trend is not evidence in the number of injury claims per 1,000 employees. It appears that there may have been a small reduction in injury claims per 1,000 employees in agriculture, forestry & fishing, construction and manufacturing. These have also been three of WorkSafe's priority sectors. However, any improvement here has been quite small, with the possible exception of manufacturing, where the decrease has been slightly larger. This is also an industry that continues to benefit disproportionately from technological advancements, such as automation, which allows workers to be removed from hazardous situations.

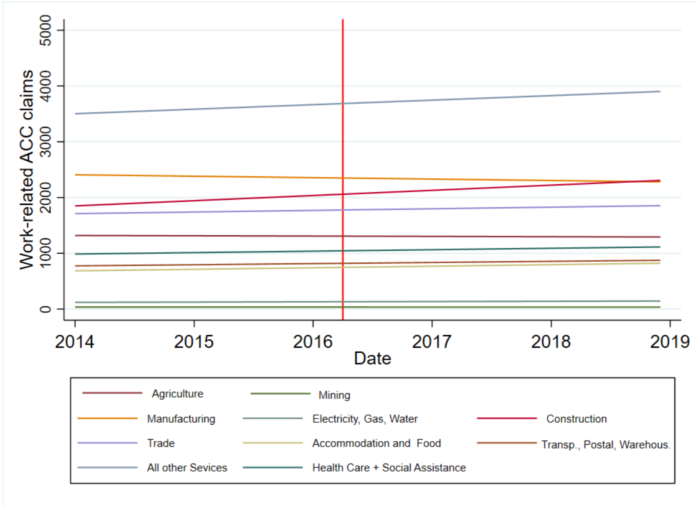
This highlights a more general issue that it difficult to attribute any improvements to WHS policy changes. The application of quasi-experimental methods involving a valid identification strategy is needed. However, it is difficult to find a valid identification strategy in this case. While most of the provisions of the HSWA came into effect in April 2016, in practice, the implementation involved a series of changes rather than a wholesale, sharp implementation. Moreover, rather than influencing how businesses managed WHS immediately, businesses would also likely to have made changes gradually, and may have even made changes in anticipation of the Act coming into effect. This makes it difficult to use techniques such as regression discontinuity design. One approach could be to use differential timing for implementation for certain regions or industries. However, it was implemented on a nationwide basis so this does not seem a promising approach. Finally, it may be possible to use the fact that it affected some industries more than others, an approach which is often used for trade policies (e.g., Bernard et al., 2006). However, it seems unlikely that there would be enough apparent differences by industry in this case.

Figure 3 Work-related injury claims by industry, 2014-2018

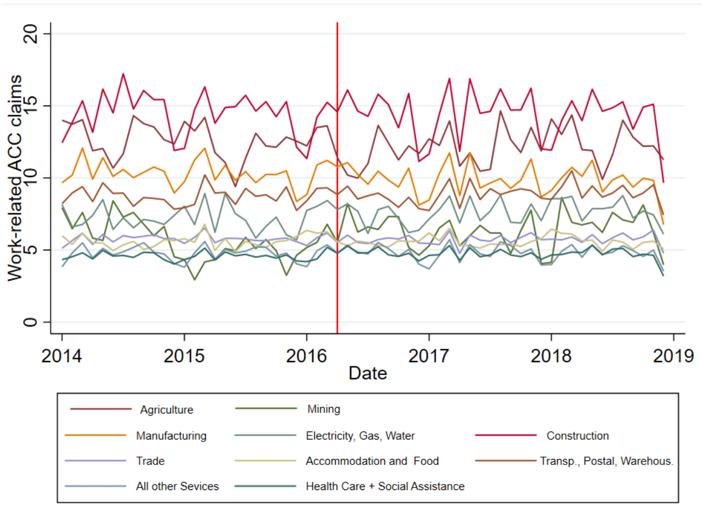
A1) Count of work-related injury claims



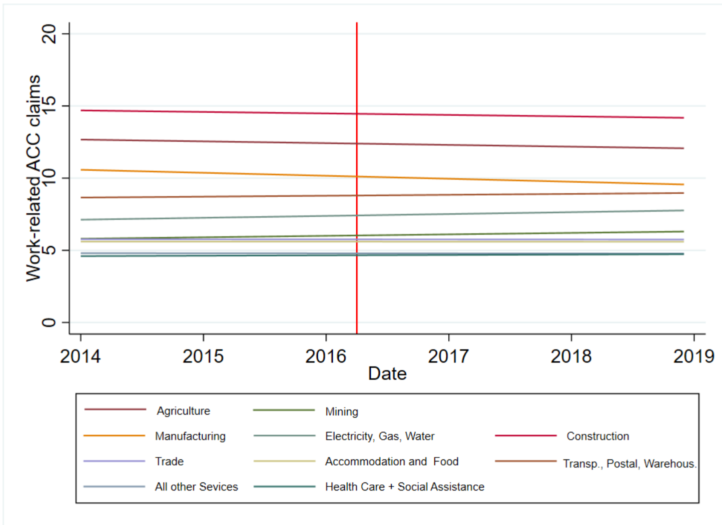
A2) Trend of work-related injury claims



B1) Work-related injury claims per 1,000 employees



B2) Trend in work-related injury claims per 1,000 employees



Notes: Trend graphs are produced using linear estimations. A detailed graph of the industries summarised in "All other services" is included in Appendix Figure A.1.

6 Conclusion and possible future directions

This report examines the relationship between workplace health and safety (WHS) outcomes, particularly work-related injury claims, and individual- and firm-level characteristics, with a focus on future-of-work trends. Despite presenting a potentially significant challenge, the possible implications for WHS of future-of-work trends have so far received scant attention. This report adds to the evidence in this area, as well as providing NZ-specific insights given NZ's unique context and regulatory settings.

We use linked administrative and survey data from Stats NZ's Integrated Data Infrastructure and Longitudinal Business Database to measure WHS outcomes and relate these to the characteristics of workers and their workplaces. The main WHS outcomes examined are work-related injury claim rates and severity measures (based on medical costs and compensated time off work) constructed from ACC injury claims data. Our main future-of-work explanatory variables come from the 2018 Business Operations Survey (BOS2018) on the 'Changing nature of work'. We also include a number of other firm-level characteristics and worker socio-demographic and economic variables. We apply multivariate regression analysis to account for the possibility of mediating relationships among the explanatory variables. However, given the one-off nature of the BOS 2018 'Changing nature of work' module, we are restricted to cross-sectional analysis. We are, therefore, unable to establish causal relationships and focus only on associations.

We find that work-related injury claims and injury severity measures are largely in line with expectations. Men, workers of Māori and Pacific ethnicities, those who have been with their employer for a shorter time, lower-income earners and those in higher-risk industries such as agriculture have a higher likelihood of having a work-related injury claim. Highlighting the challenges that an ageing workforce presents for WHS, older workers have higher injury claims and their injuries tend to be more severe than young workers. However, we find no evidence that foreign-born workers have higher injury claim rates than NZ-born workers.

We find few statistically significant relationships between future-of-work trends such as automation and flexible work practices and injury claims. One exception is the degree to which the firm has automated physical tasks, with higher automation associated with lower injury claims for male workers. However, there is no statistically significant relationship for female workers. This may be because female workers are less likely to undertake physical tasks and therefore do not benefit to the same extent as male workers in terms of automating removing workers from potentially hazardous situations.

However, it would be imprudent to dismiss the importance of future-of-work trends to WHS on the basis of these findings. One issue with BOS is that while firms may report that they have a certain policy/practice in place, we cannot gauge how, and to what extent, this is implemented. For example, while a business may have a formal flexi-work policy, use of the option by staff may be low due to, for example, it not being considered the norm within a particular workplace's culture. However, Covid-19 appears to have been a catalyst for embedding some of these practices. For example, it meant that many non-essential workers had to work from home during the lockdown, and it appears that this has led to working from home becoming more normalised post-lockdown in some workplaces.

While our focus was on cross-sectional analysis given that the BOS 2018 'Changing nature of work' module was only available at one point in time, restricting attention to individual- and basic firm-level variables would allow longitudinal analysis to be undertaken. This could allow, for example, further research into whether and how the type of work-related injury is changing over time and how this relates to changes in factors such as workers' age and industry composition.

We were also restricted in our ability to include individual-level characteristics that are likely to be strongly associated with WHS outcomes, particularly hours worked and occupation. This information is, however, available in the Census, along with other useful information such as highest qualification and the number of years immigrants have been in NZ. Future research could, therefore, include this information to give a fuller picture of issues such as the extent to which the lower average injury claims rate among female workers is accounted for by lower average working hours, or whether recent migrants have higher injury claim rates. Unfortunately, the Census 2018 may not be suitable for this purpose due to a relatively high and non-random response rate, and some of the variables of interest (such as occupation) being deemed to be of poor quality. In the future, Census 2023 could be used, however. In terms of hours, information on hours paid from IRD has recently been added to IDI for the most recent tax periods, and could be explored as an option for future research.

The Household Labour Force Survey (HLFS) also contains relevant information on hours worked, occupation, highest qualification and years in NZ for migrants. However, it is not possible to use BOS and HLFS simultaneously due to low and potentially non-representative overlap in the observations that are in both survey datasets. However, HLFS could be used if attention is restricted to population-level firm variables from administrative data only.

An additional benefit of HLFS is that every four years it includes a Survey of Working Life supplement (with the last one run in 2018). This includes information on individual-level factors that are relevant to the future-of-work such as the type of employment contract workers on, their perceptions of the degree of job autonomy and security they have, whether they have flexible working arrangements and so forth. For example, a report investigating challenges and options for measuring the gig economy highlights that this supplement may provide better information to differentiate those with more precarious employment from those in more traditional employment relationships, including gig work (Riggs et al., 2019). Therefore, analysis of individual-level future-of-work information available via this HLFS supplement would be a valuable complement to the analysis in this report using BOS firm-level future-of-work information.

Looking at work-related injury claims over time with a focus on whether patterns changed following the implementation of the Health and Safety at Work Act 2015 (HSWA), we find no evidence that injury claim rates changed following HSWA's implementation. This is perhaps unsurprising given the relatively short time since HSWA's implementation. Moreover, a general issue is that a valid identification strategy would be needed to attribute any observed change in injury claim trends to regulatory changes. However, potential candidates are not immediately apparent.

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8 Appendix

Table A. 1 Regression estimates, ACC work-related injury claims (stepwise inclusion of controls, full sample)

	b/se (1)	b/se (2)	b/se (3)
Female	-0.352*** (0.006)	-0.441*** (0.006)	-0.327*** (0.018)
Age (Ref.: 15-24 years)			
25-34 years	-0.100*** (0.011)	0.028* (0.012)	0.015 (0.016)
35-44 years	-0.205*** (0.011)	0.052*** (0.013)	0.021 (0.019)
45-54 years	-0.144*** (0.011)	0.136*** (0.013)	0.078*** (0.020)
55-64 years	-0.069*** (0.012)	0.195*** (0.014)	0.125*** (0.021)
65+ years	-0.166*** (0.017)	0.063*** (0.018)	0.000 (0.026)
Born in NZ	-0.023** (0.008)	-0.006 (0.008)	-0.012 (0.010)
Prioritised Ethnicity (Ref.: European)			
Māori	0.350*** (0.011)	0.264*** (0.011)	0.195*** (0.017)
Pacific Peoples	0.287*** (0.013)	0.188*** (0.013)	0.136*** (0.023)
Asian	-0.140*** (0.009)	-0.204*** (0.009)	-0.175*** (0.016)
MELAA	0.072** (0.026)	-0.001 (0.026)	0.019 (0.027)
Other	0.040 (0.023)	0.028 (0.023)	0.026 (0.023)
Tenure (Ref.: Less than 12 months)			
1-3 years		-0.088*** (0.009)	-0.079*** (0.013)
3-6 years		-0.187*** (0.010)	-0.168*** (0.016)
6 years or more		-0.299*** (0.010)	-0.274*** (0.018)
Gross Monthly Earning (Ref.: Less than 3000NZ$)			
3000-4500NZ$		0.203*** (0.010)	0.191*** (0.014)
4500-6500NZ$		0.006 (0.010)	0.012 (0.017)
above 6500NZ$		-0.395*** (0.010)	-0.296*** (0.022)
Multiple wage payments		0.020 (0.015)	0.008 (0.017)
New Employer		0.089*** (0.013)	0.068*** (0.016)
ANZSIC Industry Code (Ref.: Manufacturing)			
Agriculture			0.253*** (0.062)
Mining			-0.347*** (0.078)
Electricity Gas Water and Waste Services			-0.039 (0.163)
Construction			0.093 (0.077)
Wholesale Trade			-0.245*** (0.049)
Retail Trade			-0.372*** (0.050)
Accommodation and Food Services			-0.339*** (0.050)
Transport Postal and Warehousing			-0.062 (0.061)
Information Media and Telecommunications			-0.588*** (0.049)
Financial and Insurance Services			-0.497*** (0.084)
Rental Hiring and Real Estate Services			-0.375*** (0.063)
Professional Scientific and Technical Services			-0.623*** (0.043)

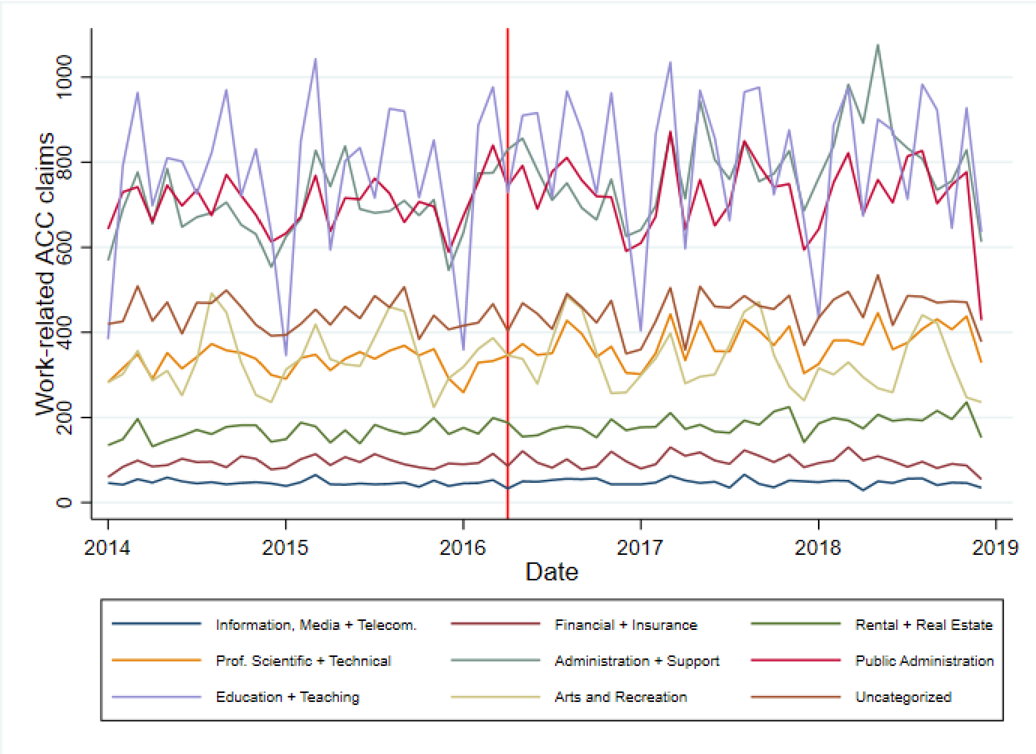
Table A. 1 Regression estimates, ACC work-related injury claims (Stepwise inclusion of controls, full sample) Continued

	b/se (1)	b/se (2)	b/se (3)
ANZSIC Industry Code (Ref.: Manufacturing) Continued…			
Administration and Support Services			-0.218*** (0.062)
Education and Training			-0.311* (0.144)
Health Care and Social Assistance			-0.250*** (0.056)
Arts and Recreation Services			-0.322*** (0.085)
Other Services			0.003 (0.077)
Firm Size (Ref.: 5 or less employees)			
6-49 employees			0.093** (0.030)
50-249 employees			0.076** (0.026)
250+ employees			-0.052 (0.037)
Firm Age (Ref.: Less than 5 years)			
5-9 years			0.062 (0.037)
10-24 years			0.029 (0.044)
25-49 years			0.006 (0.040)
50 years or more			-0.007 (0.056)
Overseas Ownership Rate			-0.002*** (0.000)
Firm profit (amount)			-0.014 (0.023)
Firm profit (indicator)			-0.025 (0.029)
Cluster level	individual	firm	firm
Observations	8,025,291	8,025,207	8,025,207
Share	0.704	0.704	0.704
R^2	0.000877	0.00174	0.00269

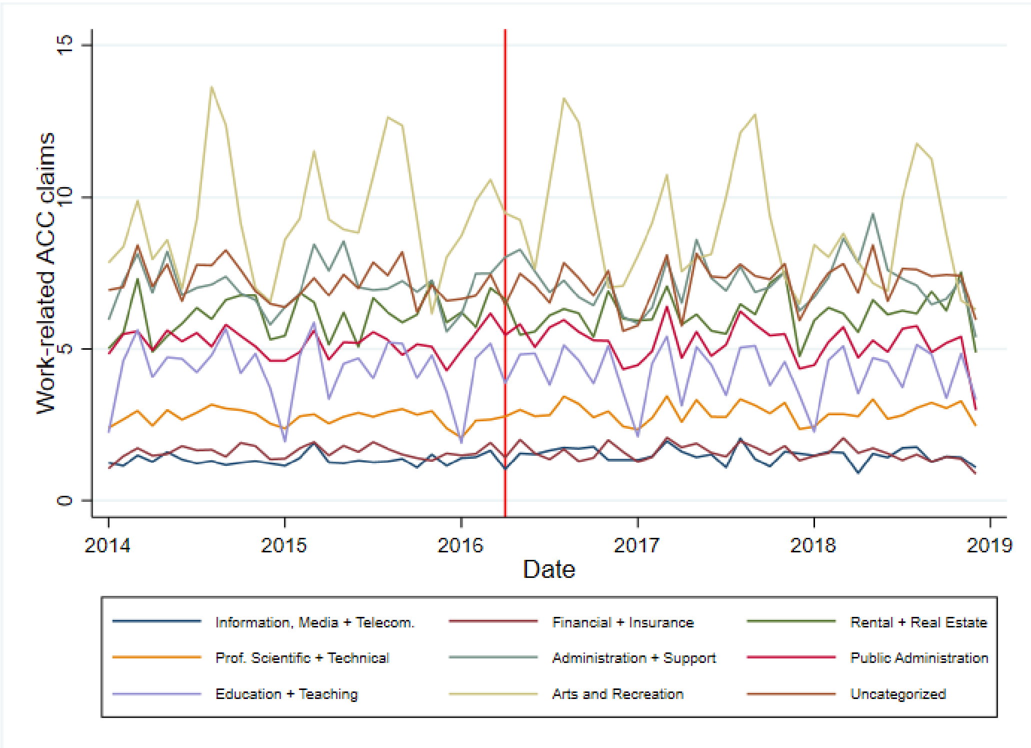
Notes: b/se are the estimated beta coefficient and standard error respectively. p-values: *, **, *** represent statistically significant differences at the 10%, 5% and 1% levels respectively. Standard errors are clustered to account for serial correlation. Firms with missing profit information were assigned a profit value of zero and an indicator for missing profit information was also included.

Figure A. 1 Work-related injury claims by industry (other services), 2014-2018

A) Count of Work-related ACC claims



B) Work-related ACC Claims per 1000 Employees



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