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HĪKINA WHAKATUTUKI

The emissions exposure of workers, firms and regions

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HĪKINA WHAKATUTUKI

Authors

Transitions Strategy Team, Economic Strategy Branch

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Ministry of Business, Innovation & Employment
PO Box 1473
Wellington 6140
New Zealand
www.mbie.govt.nz
0800 20 90 20
Media enquiries: media@mbie.govt.nz

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Integrated Data Infrastructure disclaimer

These results are not official statistics. They have been created for research purposes from the Integrated Data Infrastructure (IDI) and Longitudinal Business Database (LBD) which are carefully managed by Stats NZ. For more information about the IDI and LBD please visit https://www.stats.govt.nz/integrated-data/.

The results are based in part on tax data supplied by Inland Revenue to Stats NZ under the Tax Administration Act 1994 for statistical purposes. Any discussion of data limitations or weaknesses is in the context of using the IDI for statistical purposes, and is not related to the data's ability to support Inland Revenue's core operational requirements.

Abstract

We calculated the emissions intensity (tonnes of carbon dioxide equivalent emissions per dollar of gross output) for different industries across the New Zealand economy. This was used to examine differences in the characteristics of workers and firms depending on industry emissions intensity. We find that high emissions intensity industries tend to have a high proportion of workers who are male, Māori, and with low or no formal qualifications. Earnings and employment characteristics vary significantly across high emissions industries. Some are characterised by relatively stable and well-paid work, while others have higher rates of worker turnover, more short employment spells and lower average remuneration. We also find that employment in high emissions industries is more heavily concentrated in certain regions. The results do not predict which industries will grow and contract as more stringent climate change policies are introduced, but instead provide insights about the firms and workers most likely to undergo change in the transition to a low-emissions economy.

JEL classification

Q01, Q52, J20, R11

Keywords

Climate change, emissions, firms, workers

Executive summary

New Zealand's transition to net zero emissions will require significant transformation of the economy, and it is important that the transition is managed in a way that maintains the wellbeing of people and communities. This paper helps to build a better understanding of the workers, firms and regions likely to be most affected in the transition to a low-emissions economy.

We calculated the emissions intensity (tonnes of carbon dioxide equivalent emissions per dollar of gross output) for 106 sub-industries across the New Zealand economy. Using this calculation, industries were grouped into four categories depending on their emissions intensity and we examined differences in the characteristics of workers and firms across these groupings. We also looked at differences in the spatial distribution of industries across the country. To the extent allowable under data confidentiality rules we have also examined firm and workforce characteristics for specific high emissions intensity industries.

Importantly, the research does not model or predict the specific changes that emissions-intensive industries will experience in future

The research presents a snapshot of the emissions intensity of different industries which provides a guide as to the groups of workers and firms most likely to be impacted in the transition to a low-emissions economy. The research does not attempt to model or predict how those impacts will play out in practice. A wide range of factors will affect how the transition will impact different industries. For example, some emissions-intensive industries may have a range of low-cost emissions abatement opportunities or may be able to pivot to produce different goods or services. For these industries and their workforce, the impacts stemming from the transition may be minimal. Other emissions-intensive industries may face a more challenging outlook due to the absence of viable abatement opportunities.

The workforce in emissions-intensive industries is more likely to be male, Māori and have lower qualification levels

The workforce in emissions-intensive industries is male-dominated. Males accounted for 68 per cent of employment in emissions-intensive industries compared with 47 per cent for low emissions intensity industries. This is evident across nearly all emissions-intensive industries and is particularly apparent in road and rail transport and in heavy manufacturing industries such as cement and metal manufacturing.

Māori account for a higher share of employment in emissions-intensive industries (23 per cent) than in low emissions intensity industries (14 per cent). This is driven primarily by a high share of Māori employment in sheep and beef farming, meat manufacturing and road and rail transport.

Qualification levels are lower on average in emissions-intensive industries with around 75 per cent of employees having no qualifications or a qualification at level 1 – 3 on the National Qualifications Framework. Industries with particularly high shares of workers with no or low qualifications include sheep and beef farming, meat manufacturing and road and rail transport.

There is significant variation in the average age of workers and remuneration levels across different emissions-intensive industries

The average age of employees in emissions-intensive industries is similar to the workforce for the economy as a whole, however there is significant variation across individual industries. Employees in emissions-intensive agricultural industries tend to be younger, while the workforce for heavy manufacturing industries, road and rail transport, and coal, oil and gas is, on average, much older.

Average earnings for emissions-intensive industries are on par with lower emissions industries. Within emissions-intensive industries there are some pockets of highly paid jobs (dairy manufacturing, metal manufacturing, chemical manufacturing, coal, oil and gas, and electricity and gas supply). On average, jobs in high-emissions agricultural industries and food processing (except dairy manufacturing) are lower paid.

High-emissions industries experience slightly higher rates of job churn (as measured by the share of worker-job months where an employee is starting or ending an employment spell) which is driven by the agricultural industries. Industries characterised by particularly stable employment arrangements include chemical and metal manufacturing. Workers in agricultural industries are also much more likely to be working less than full-time whereas heavy manufacturing, electricity and gas supply and coal, oil and gas industries have higher shares of full-time work.

Some regions have higher shares of their workforce employed in emissions-intensive industry

The emissions-intensive workforce is concentrated in rural regions with specific industry concentrations varying region by region. The four regions with the highest share of their workforce employed in high-emissions industries are Southland, Gisborne, Taranaki and West Coast. Regions where the majority of the population is based in cities, such as Wellington, Auckland and Nelson have the lowest shares of employment in emissions-intensive industries.

On average, firms in high-emissions industries are slightly older and smaller than firms in low-emissions industries

On average, firms in emissions-intensive industries are slightly older than those in low-emissions industries and this is reasonably consistent across the each of the emissions-intensive industries.

On average, firms in emissions-intensive industries are smaller (in terms of number of employees) than low emissions intensity industries, this is driven largely by

emissions-intensive agricultural industries. Emissions-intensive industries where the average firm size is relatively large include meat and dairy manufacturing, and electricity and gas supply.

Key implications for workers, firms and regions

The composition of the workforce varies significantly across emissions-intensive industries. The characteristics of workers that will be impacted during the transition to a low-emissions economy will depend on the pace and nature of change that specific firms and industries undergo during the course of this transition. As noted, this report does not predict the extent of impacts.

Māori account for a higher share of employment in emissions-intensive industries than in low emissions intensity industries. This is particularly apparent in industries characterised by relatively low qualification levels. Māori employees have historically fared poorly in transitions being more likely to be made redundant during recessions and finding it more difficult to find re-employment (Reid et al., 2020). Accordingly, it is important that labour market policies, skills and education programmes and measures to support growth of low-emissions economic activity are effective in developing employment and business opportunities for Māori.

This research shows that the workforce for higher emissions agricultural industries is younger than the workforce for the economy as a whole. Based on past experience, younger workers are more vulnerable to job displacement during downturns and shocks (Maré, 2018). Policy measures to support younger displaced workers should focus on developing the longer term education and skills that workers will need to be resilient to change throughout their working life.

Particular challenges that may face older workers in the event of job displacement include having higher levels of job-specific human capital and less ability to relocate for alternative employment opportunities owing to family commitments. There are concentrations of older workers in some heavy manufacturing industries along with the road and rail transport, and coal, oil and gas industries.

Emissions-intensive industries have high concentrations of workers with low or no qualifications. In the event that there is a decline in demand for labour in these industries, short-term redeployment opportunities will need to align with the existing skills mix of the workforce.

While it is difficult to predict long-term skill demand, research suggests that new skills will likely be required both as new types of work emerge and jobs in existing industries are transformed. This signals a need for effective retraining and upskilling options, and the development of transferrable skills that are compatible with multiple roles as a form of insurance against future uncertainty. It also points to the importance of effectively monitoring emerging trends and making information on these readily available to businesses, workers and learners so that they can make decisions about what skills to invest in.

There is a clear spatial dimension to emissions-intensive employment, reinforcing the need for Government to work closely with transition-exposed regions to develop a long-term approach to transitioning local economies and supporting the growth of transition-aligned industry. Negative impacts of job displacement are likely to be more acute when they occur in remote rural regions with fewer alternative employment opportunities. This points to a need for more targeted interventions to support displaced workers in the event of a closure that accounts for a significant share of local employment.

Studies examining the resilience of firms to shocks or transitions suggests that generally larger and more mature firms are more resilient. The presence of numerous small firms in high-emissions industries (particularly agriculture) indicates that these firms may require additional support in order to successfully manage this transition, for example through adopting low-emissions technologies and farming practices.

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1 Introduction

A just transition to a low-emissions economy is a key component in the Government's Economic Plan to make New Zealand more productive, sustainable and inclusive. This transition will require significant cuts to greenhouse gas emissions and increasing removals by carbon sinks. In particular, through the 2019 amendments to the Climate Change Response Act 2002, New Zealand has set domestic emissions reduction targets in legislation. Emissions of greenhouse gases (except biogenic methane) are required to reach net zero by 2050. Emissions of biogenic methane must reduce to at least 24 to 47 per cent below 2017 levels over the same period, and must reduce by at least 10 per cent by 2030.

Achieving these emissions reduction targets will require a significant transformation of the economy. It is important that the transition is managed in a way that supports wellbeing and ensures that the overall balance of impacts falls evenly across society and does not re-inforce existing inequities.

The Climate Change Response Act now provides a framework by which New Zealand will respond to climate change challenges. Part of this process requires the Government to set formal emissions budgets that step progressively toward the 2050 target. The Government must develop and publish an emissions reduction plan that sets out the actions it will take to drive emissions reductions. Importantly, the emissions reduction plan must include a strategy to manage the impacts that the transition has on employees and employers, regions, iwi and Māori, and wider communities.

In order to plan for the transition to a low-emissions economy and to prepare strategies to manage the impacts, it is important to develop an evidence base that builds a better understanding of how impacts are likely to play out over the course of the transition. Anticipating these impacts in advance is challenging – as noted by the Productivity Commission, "the transition to a low-emissions economy will be a long journey to a known and desired destination, but through very uncertain terrain" (New Zealand Productivity Commission, 2018, p. 10).

Rather than attempting to predict specific impacts in advance, this research aims to build a richer picture of the firms, workers and regions that are more likley to be exposed to change through this transition.

Our underlying measure of exposure is based on a calculation of the tonnes of carbon dioxide equivalent emissions per dollar of gross output across different industries. Using this calculation we have grouped industries into different categories depending on their emissions intensity and examined differences in the characteristics of workers and firms across these groupings. We have also looked at differences in the spatial distribution of industries across the country. And to the extent allowable under data confidentiality considerations, we have examined firm and workforce characteristics separately for specific highly emissions-intensive industries.

The starting assumption for this approach is that firms in industries that are more emissions-intensive are most likely to have to undergo significant changes in the way

that they operate in response to pressures to reduce emissions. These include policies such as the New Zealand Emissions Trading Scheme and other pressures to reduce emissions, such as changing consumer preferences. These changes will be felt by workers in these firms and will be felt within the communities where these firms are located – particularly if there are concentrations of emissions-intensive industry in certain parts of the country.

There are limitations to this approach (these are discussed in full in chapter 2). In particular, emissions intensity is not a predictor of the sorts of impacts that different industries might experience over the course of a transition to a low emisisons economy. A wide range of factors will affect how the transition will impact different industries. For example, an industry may be highly emissions-intensive, but might also have a range of low-cost abatement opportunites, while a less emissions-intensive industry may face a more challenging outlook due to the absence of viable abatement opportunities. Further, impacts from this transition will likely have flow-on impacts well beyond the direct impacts that are observed in emissions-intensive firms.

1.1 Chapter summary

This report is structured as follows:

Chapter 2 contains the methodology used in this research including the methodology for calculating industry emissions intensity. It also discusses the limitations of this research and how the results should be interpreted.

Chapter 3 sets out four groupings for industries depending on their level of emissions intensity and describes the main activities undertaken by industries in each grouping along with their major emissions sources.

Chapter 4 sets out descriptive data about workers (such as age, ethnicity and gender) depending on the emissions intensity of the industry they are employed in. The chapter also examines data on the physical location of the workforce depending on the emissions intensity of the industry they work in.

Chapter 5 sets out descriptive data about the characteristics of employment in different industries including average wages and hours worked.

Chapter 6 sets out descriptive data about the characteristics of firms depending on industry emissions intensity.

Chapter 7 presents the key conclusions from this research and discusses potential implications for policies to manage the impacts of the transition to a low-emissions economy.

2 Methodology

This chapter summarises the methodology used to calculate industry emissions intensity along with the data sources used to describe firm and workforce characteristics within these industries.

2.1 Emissions intensity (C-vector) calculation

We use the carbon intensity vector (c-vector) developed in Romanos et al. (2014), and expanded in Allan et al. (2015) and Allan and Kerr (2016), to rank the emission intensity of different industries. The c-vector calculation is described by the following equation:

$$c = eF(I - A)^{-1}$$

where the c-vector (c) is a 1 x n vector of emissions intensities, measured as tonnes of carbon dioxide equivalent per dollar of gross output ($t - CO_2e/\$$); e is a vector of emissions factors for both fossil fuels and process emissions; F is a matrix of industry fuel requirements; and $(I - A)^{-1}$ is the total requirements matrix from the 2012/13 national accounts input-output tables produced by Statistics New Zealand.

Key features and limitations of this approach to calculating emissions intensity include:

- The calculation produces a measure of emissions intensity per dollar of output rather than total emissions. Accordingly, an industry with relatively low emissions intensity could still account for a large share of total emissions if the industry was sufficiently large.
- It is a consumption-based accounting approach and accordingly it captures direct emissions from the industry (for example fossil fuel use) as well as the emissions intensity of inputs used by that industry.[1]
- The emissions intensity of inputs used in different industries is derived using domestic data and the emissions intensity calculation assumes that all firms and industries source their inputs domestically. Accordingly, the calculation will overstate emissions intensity where firms are able to source lower-emissions inputs from overseas.
- The approach calculates a gross emissions intensity meaning that it does not capture any emissions sequestration that could be attributed to different industries.

For more information about the construction of the c-vector, see Allan et al. (2015), and Allan and Kerr (2016).

[1] For example, the emissions intensity of the dairy product manufacturing industry reflects both energy used in the manufacturing process as well as emissions associated with the production of dairy products.

Our analysis uses the 2015 c-vector output, which gives a c-vector value (i.e., emissions factor) for industries at level 4 on the New Zealand Standard Industrial Output Categories (NZSIOC). Using the national accounts working industries concordance, we map the NZSIOC industry codes to the level 4 Australia and New Zealand Standard Industrial Classification 2006 (ANZSIC06) industry codes. The ANZSIC06 industry codes enable us to merge the c-vector data with firm- and employee-based tables in Statistics New Zealand's Integrated Data Infrastructure (IDI) and the Longitudinal Business Database (LBD). Due to Statistics New Zealand's confidentiality and suppression rules, we primarily analyse industries using the level 3 ANZSIC06 codes.

We rank all industries by their NZSIOC c-vector value. From this ranking, four reasonably distinct groupings of industries emerged: rank 1-20 which we classify as high emissions intensity, rank 21 – 28 (medium-high), rank 29 – 45 (medium), and rank 46 – 106 (low emissions intensity). Detail on the composition of each of these groupings is set out in the following chapter.

Since the c-vector methodology for industries is primarily based on the emissions of inputs into the production process, the emissions factors for industries do not include emissions from household consumption of their products. For some industries, emissions from household consumption will be low. However, for other industries like gas supply, most of the emissions will be from consumption. Hence, emissions factors are also computed for the emissions from household consumption of direct energy use. For energy use, we group together the related industries from which the household end users are primarily purchasing these products. For example, direct use of gas by households has high c-vector ranking; hence, we also include the gas supply industry in the high emissions intensity group. This logic is applied to all industries which flow into the household use of petrol, electricity, gas, other vehicle fuels and lubricants, liquid fuels, and solid fuels.

2.2 Workforce and employment characteristics data

Employee-level data are primarily sourced from the IDI, which houses data on a range of individual-level characteristics, such as education, training, income and work, benefits and social services, health and housing. This data is "de-identified" with information like names, date of birth and addresses removed so that individuals can not be identified (Statistics New Zealand, 2020). A key advantage of the IDI is the ability to link individuals across all databases using a unique identifier.

Across multiple datasets in the IDI, we observe the following worker-level characteristics:

- Gender, age and ethnicity
- Highest education qualification
- Migrant status
- Annual equivalised earnings from wages and salaries

- Location (the regional council area where the worker is employed)
- Number of jobs an individual has per month
- Number of worker-job months worked in an industry per year, and whether these months are spell starts, spell ends, or short spells.

These employee-level data are presented for the 2017 calendar year to show worker characteristics at the *worker-job* level in different industries. A worker-job is defined as a period of employment with the same employer and with (at most) one month breaks in observed earnings (see Fabling & Maré (2015) for examples and definitions). Therefore, if an individual has multiple jobs with different employers, they would appear in this dataset once for every job they are paid for.

The worker-level characteristics only capture data relating to employees and does not capture working proprietors. In some industries working proprietors are an important source of labour and it is likely that the characteristics of working proprietors will be materially different to employees. This limitation is discussed in more detail in chapter 4.

Alongside data from the IDI, we also sourced the following descriptive data about employment characteristics using 2018 census data:

- average number of hours worked by individuals in their main job, per week;
- average number of hours worked by individuals in their main job per week, conditional on working full-time in that job;
- average number of hours worked by individuals in their main job per week, conditional on working part-time in that job; and
- number of workers who work full-time or part-time in their main job.

2.3 Firm characteristics data

In the LBD, data are available at different firm levels, which reveals information about the structure of the firm. The data presented in this report is based primarily at the enterprise level. This pertains to a tax-reporting legal entity (e.g., sole proprietor, partnership, company, etc.). We also sourced some data at the geographic unit level which shows the individual physical locations associated with an enterprise such as storefronts, headquarters, warehouses, or plants.

Across multiple tables in the LBD, we collect data on the following firm characteristics: for the 2017 calendar year:

- total employment (by FTE and head count);
- firm age;
- sales and purchases; and
- the regional council area where geographic units are located.

Statistics New Zealand also receives the Employer Monthly Schedule (EMS) data from Inland Revenue, which is a job-level dataset that is submitted by firms on behalf of employees for PAYE purposes. This gives information about an employee's monthly wages and salaries earnings, but also on the total wage bill paid by the enterprise each month.

The LBD also contains information on the first (birth date) and last financial year (cease date) for which an enterprise recorded having employment. We supplement this information with information from the employment tables as needed (e.g., if the birth date is missing, we use the first date we see the enterprise in the EMS data). This information was also used to calculate the share of enterprises across different industries that were new (births), ceased operating (deaths) or continuers for the 2010 to 2016 financial years.

Statistics New Zealand also receives records of Inland Revenue's GST returns, which are filed on a monthly, bi-monthly or six-monthly basis (depending on the size of the firm) at the enterprise level. The raw data have been manipulated as described in Fabling & Maré (2019) to provide monthly enterprise-level statistics on GST sales and purchases.

2.4 Limitations

The methodology used in this research has some important limitations that should be kept in mind when considering the results. The research presents a snapshot of the emissions intensity of different industries which serves as a proxy for the groups that are most likely to be impacted in the transition to a low-emissions economy. Accordingly, the analysis does not seek to identify the firms and workers exposed to the second and third order impacts that will likely be felt through the economy – for example where firms with a low emissions intensity are providing services to more emissions-intensive firms. However, by analysing the spatial distribution of emissions-intensive firms we are able to draw some inferences about where some second and third order effects are likley to be most pronounced.

Many different factors over and above emissions intensity will determine how impacts play out in practice, most of which are very difficult to predict in advance. One important factor is the range and cost of current and future abatement opportunities. For example, an industry may be highly emissions-intensive, but might also have a range of low-cost abatement opportunites, while a less emissions-intensive industry may face a more challenging outlook due to the absence of viable abatement opportunities.

The policy decisions taken by current and future governments will also affect the timing and magnitude of impacts over the course of the transition. For example, under current policy settings, not all emissions are treated equally under the New Zealand Emissions Trading Scheme. Certain types of emissions are not included in the scheme, and some emitters are shielded from facing the full emissions price under the industrial allocation policy for emissions-intensive and trade exposed firms. Accordingly, these settings are likley to play a major role in determining the type of impacts and their magnitude.

In addition, New Zealand has a separate emissions reduction target for biogenic methane where emissions are required to reduce by between 24 and 47 per cent by 2050 (all other gases must reduce to net zero by 2050). Accordingly the impacts for emissions-intensive industries are likely to differ depending on the composition of their emissions profile.

There are also some limitations in the nature and availability of data that is used in this study – these are described more fully earlier in this chapter. The data is used to present a descriptive snapshot of the characteristics of firms and workers based on the year that data was sourced. Given the ongoing changes to firm and worker activity across the economy, we would expect some gradual changes to results over time. Under normal circumstances we would expect these changes to be relatively minor. However, the impacts of COVID-19 have likely accelerated the rate of change across the economy and increased the likelihood that firm and worker composition has materially changed in some parts of the economy.

3 Industry characteristics and emissions intensity

The emissions intensity of firms and industries varies significantly across the New Zealand economy. As set out in the previous chapter, we have ranked industries in the New Zealand economy based on their emissions intensity. This revealed four relatively distinct groupings of industries which are termed high emissions intensity, medium-high, medium and low. We have analysed the characteristics of firms and workers within each of these industry groupings and have also (to the extent that the data permits) examined firm and workforce characteristics separately for those industries in the high emissions intensity grouping.

The remainder of this chapter sets out the different industries included in each grouping alongside a summary of the main emissions sources and the types of activities performed in each grouping.

3.1 High emissions intensity industries

The emissions factors in the c-vector are calculated for industries using Level 4 New Zealand Standard Industrial Output Categories (NZSIOC) which are then mapped to the Australia and New Zealand Standard Industrial Classification 2006 (level 3) in order to link them to the IDI and LBD. When this mapping is done, the grouping expands to cover a larger number of industries. Because some of these industries are small, some similar industries were merged for the purposes of this analysis, leaving a total of 23 industries in the high emissions intensity grouping.

The 23 industries collectively account for approximately 10% of New Zealand's employment and fall into four broad groupings: agriculture; food manufacturing; heavy manufacturing; and distribution and extraction. For presentation purposes, industry names used in this report are simplified – appendix A lists the full Australia and New Zealand Standard Industrial Classification 2006 industry names that correspond to each abbreviated industry name.

It is also important to reiterate that the rankings are based on the emissions factor, which is the emissions per dollar of output, and not based on total emissions. Hence, the highest ranked industries are not necessarily the largest emitters.

3.1.1 Agricultural industries

Six agricultural industries fall within the high-emissions grouping: sheep and beef farming; dairy farming; poultry farming; deer farming; other livestock farming; and other crop growing[2]. Dairy farming and sheep and beef farming account for

[2] The Australia and New Zealand Standard Industrial Classification 2006 contains four crop growing industries: nursery and floriculture; mushroom and vegetable growing; fruit and tree nut growing; and a residual industry "Other crop growing" which includes the production of sugar cane, cotton and animal fodder crops such as hay and silage.

approximately 49% and 36% of total job months in agricultural industries with the other four industries accounting for the remaining 15%.

Farming activity in the primary sector creates biogenic methane and nitrous oxide gases which make up around half of New Zealand's total emissions. Methane is produced by ruminant animals as a by-product of the digestion process. Nitrogen fertiliser used in pastoral and crop farming also creates nitrous oxide gas. All forms of animal waste produce both methane and nitrous oxide gases (Ministry for Primary Industries, 2020).

3.1.2 Food manufacturing

Four industries relating to food processing and manufacturing fall within the high-emissions grouping: meat manufacturing; dairy manufacturing; fruit & vegetable processing; and other food manufacturing.[3]

One of the main sources of emissions for food manufacturing is from the combustion of fossil fuels to generate process heat. For example, processes in dairy manufacturing requiring process heat include pasteurisation and spray-drying to produce products such as milk powder (MBIE, 2019a). In 2016, the dairy manufacturing industry used 28.4 peta joules (PJ) of fuel to generate process heat of which coal accounted for 54% and natural gas for 38%. Similarly, meat manufacturing plants use boilers fuelled by coal and natural gas to produce steam and hot water for processes such as cleaning and sterilisation of equipment and rendering of animal by-products (MBIE, 2019b).

A second key source of emissions in food manufacturing industries is that the main inputs for some of these industries (e.g., milk and cattle) are themselves from emissions-intensive industries.

3.1.3 Heavy manufacturing

Seven industries within the high emissions intensity grouping are classified here as 'heavy manufacturing': metal manufacturing;[4] chemical manufacturing; basic polymer manufacturing; glass manufacturing; ceramic manufacturing; cement manufacturing; and other non-metallic mineral manufacturing.

Major sources of emissions in these manufacturing industries include emissions from fuels such as natural gas that are burnt to produce energy and emissions from industrial processes that chemically or physically transform materials. Examples of industrial process emissions include the release of CO_2 that occurs when limestone is baked at high temperatures to produce lime (which is a core input to cement). Similarly, the production of iron and steel and aluminium both result in process emissions that are attributed to the metal manufacturing industry.

[3] 'Other food manufacturing' combines the following ANSZIC 06 level 3 industries: oil and fat manufacturing, grain mill and cereal product manufacturing, bakery product manufacturing, sugar and confectionary manufacturing, and a residual category named other food product manufacturing.

[4] 'Metal manufacturing' combines the following ANSZIC 06 level 3 industries: basic ferrous metal manufacturing, basic ferrous metal product manufacturing, basic non-ferrous metal manufacturing, and basic non-ferrous metal product manufacturing.

3.1.4 Extraction and distribution

Six industries relating to extraction and distribution fall within the high-emissions grouping: electricity on-selling and electricity market operation (abbreviated henceforth as 'electricity on-selling'); fuel retailing; electricity and gas supply[5]; mineral, metal and chemical wholesaling; coal, oil and gas[6]; and road and rail transport.[7]

For the first three of these industries (i.e., electricity on-selling, fuel retailing, and electricity and gas supply), emissions from household consumption of goods is an important driver of emissions intensity. For example, the activity of fuel retailing has a relatively low emissions intensity (similar to other retail activities); however, household use of fuels generates high emissions. The high emissions intensity profile for mineral, metal and chemical wholesaling stems from the emissions intensity of the products that are sold. The coal, oil and gas industry includes petroleum refining which generates significant emissions as a result of the combustion of fossil fuels to generate process heat. Consumption of petrol and diesel are the main sources of emissions for the road and rail transport industry.

3.2 Medium-high emission industries

This grouping accounts for around 4% of employment in New Zealand and mainly consists of industries in manufacturing and transport, such as paper and metal product manufacturing, and water freight and water passenger transport. Emissions in these industries are mostly a result of chemical processes or come from fuel combustion. Also included in this category are some agricultural industries such as aquaculture, and vegetable and fruit growing. For these industries, main emission sources include feed production for fish and other water animals, and fertiliser use.

3.3 Medium emission industries

Industries in the medium emissions grouping account for 15% of employment and are more wide-ranging in business activity than other groupings. A significant proportion is however in the manufacturing sector; for example the manufacturing of fertiliser, machinery and equipment, pharmaceutical and chemical product, wood product, and fabric. Other industries include hunting and trapping, forestry and logging,[8] air and space transport, mining, hospitality and food services, and grocery wholesaling.

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[5] 'Electricity and gas supply' combines the following ANSZIC 06 level 3 industries: electricity generation, electricity distribution, electricity transmission and gas supply.
[6] 'Coal, oil and gas' combines the following ANSZIC 06 level 3 industries: coal mining, oil and gas extraction, exploration, and petroleum refining and petroleum and coal product manufacturing.
[7] 'Road and rail transport' includes the following ANZSIC 06 level 3 industries: rail freight transport, rail passenger transport, road freight transport, road passenger transport.
[8] As noted in chapter 2, the measure of emissions intensity used in this research only captures gross emissions. Accordingly, carbon sequestration through afforestation is not reflected in the emissions intensity of the forestry and logging industry.

3.4 Low emission industries

Industries included in the low emissions intensity grouping are predominantly from the services sector and account for 72% of New Zealand's total employment. Daily activities in these industries generally involve the provision of professional services in an office building environment which requires low energy use. Broad categories include the provision of banking, health, legal and education services, wholesaling and retailing, entertainment activities, and government administration. A number of manufacturing industries which do not involve high levels of energy use are also included in this grouping.

4 Workforce characteristics

This chapter sets out the results showing workforce characteristics depending on the emissions intensity of the industry they are employed in. The results are first presented at an aggregate level for the four broad industry groupings presented in chapter 3. We then look in more detail at the workforce characteristics for specific industries within the high emissions intensity grouping.

The worker-level characteristics presented in this chapter are based on employees and do not capture the characteristics of working proprietors. At the aggregate level, working proprietors account for a relatively small share of the workforce – 6% for the emissions-intensive grouping and 3% for the low emissions grouping. Accordingly, any differences in the characteristics of working proprietors relative to employees is unlikely to materially alter the statistics for industry groupings shown in this chapter.

However, working proprietors do account for a significant share of workers in some high-emissions industries. In particular, working proprietors account for approximately 10% to 17% of the workforce in each of the high emissions intensity agricultural industries except for poultry farming. Accordingly, characteristics for an important share of the workforce in those industries are not captured in this analysis. For example, we find that workers in high emissions intensity agricultural industries tend to be younger than workers in other high emissions intensity industries (section 4.4). However, it is likely that working proprietors are on average older, and hence if included would result in a higher average age for those agricultural industries.

4.1 Gender

The workforce for more emissions-intensive industries is clearly male dominated, with males accounting for 68% and 66% for the two higher emissions groupings (Figure 4.1). By contrast, males comprise just 47% of the low-emissions workforce.

Figure 4.1 Workforce gender across industry groupings

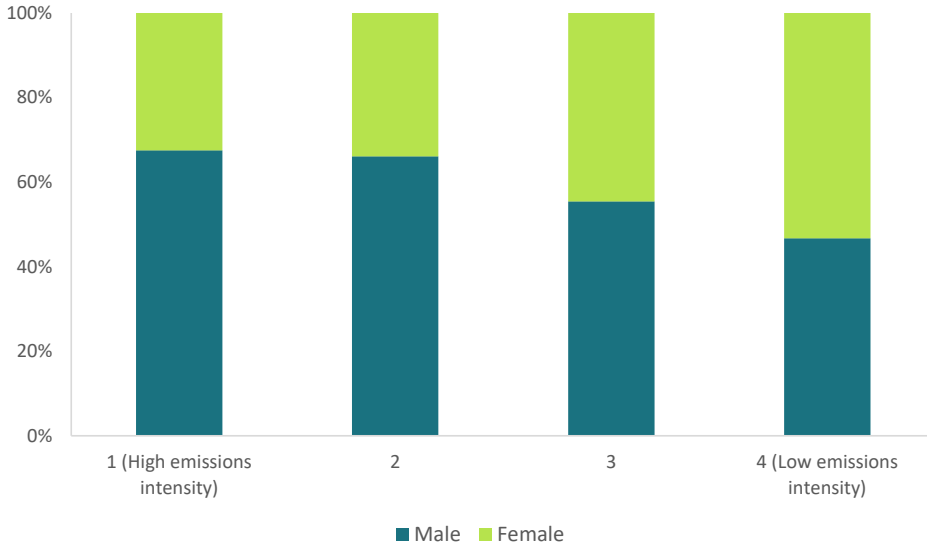
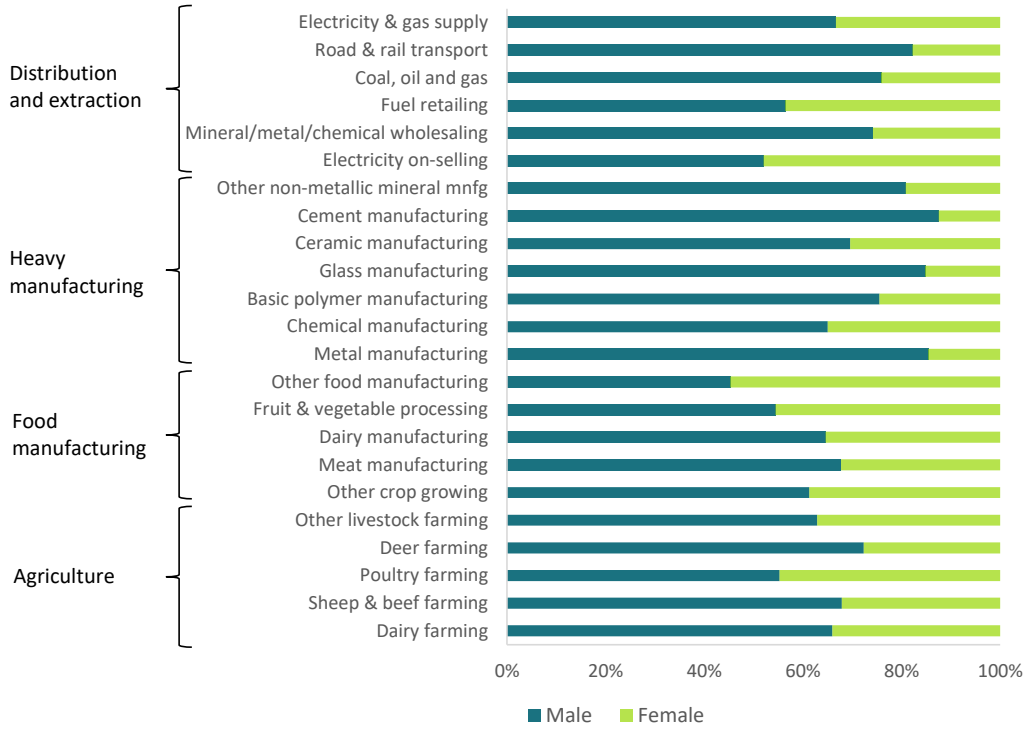


Figure 4.2 shows that the finding for emissions-intensive industries to be male-dominated is consistent across most of the industries that make up the high emissions intensity grouping with the exception of the "other food manufacturing" industry. Emissions-intensive industries with particularly high shares of male employment (more than 80%) are glass, metal, cement and non-metallic mineral manufacturing, and road and rail transport.

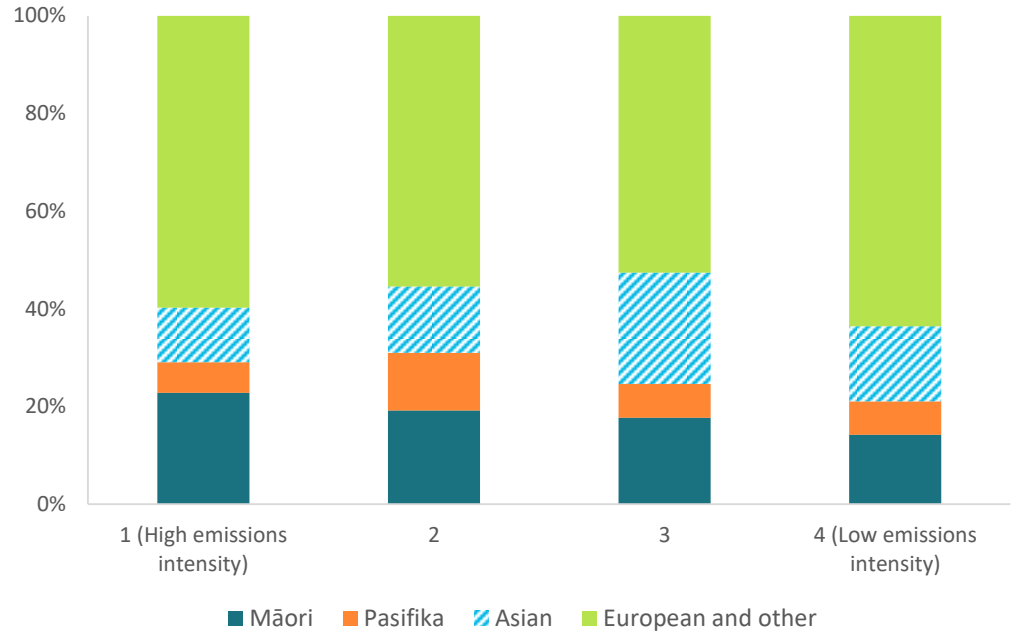
Figure 4.2 Workforce gender for high emissions intensity industries



4.2 Ethnicity and migrant status

A relatively clear pattern is also evident in the ethnicity of the workforce across the four industry groupings (Figure 4.3). Māori account for 23% of the workforce employed in highly emissions-intensive industry – a share that steps down to 14% for low-emissions industry. By contrast, the share of the workforce that is European or Other is higher in the low-emissions category than each of the three higher emissions industry groupings. A slightly more mixed picture is evident for Pasifika and Asian workers, with relatively high shares in the medium-high and medium emissions intensity groupings respectively.

Figure 4.3 Workforce ethnicity across industry groupings

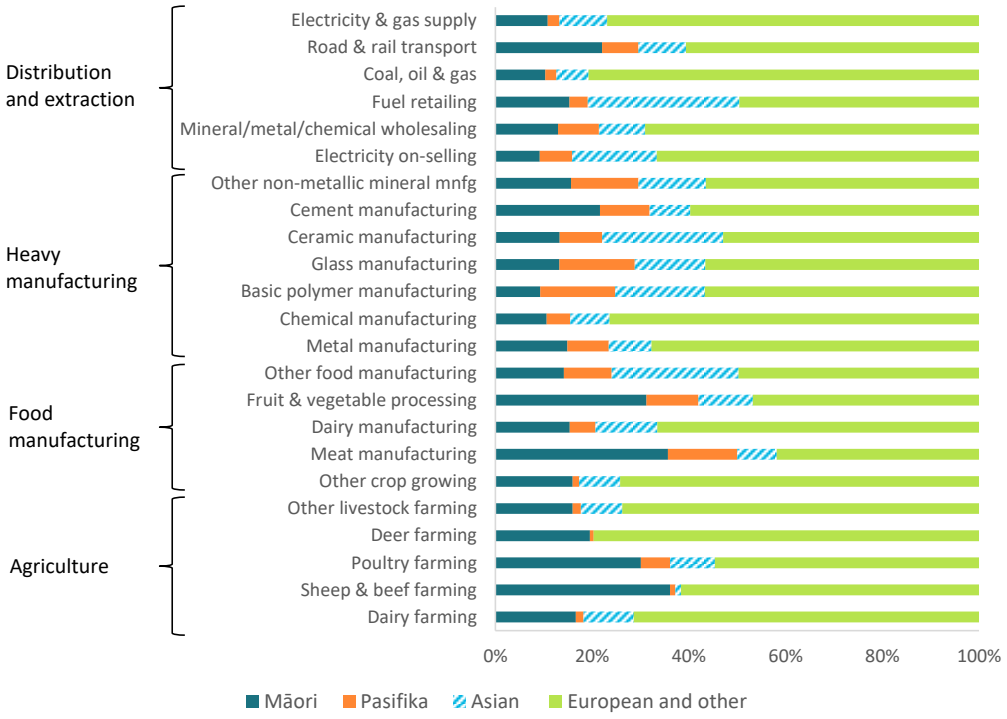


As shown in Figure 4.4, the higher share of Māori employment in the high emissions intensity industry is driven largely by relatively high employment shares in sheep and beef farming (where Māori comprise 36% of the total workforce); meat manufacturing; road and rail transport; and to a lesser extent, dairy farming. Together, these industries account for 74% of total Māori employment in high emission industries.

The overall share of Pasifika employment in high emissions-intensity industries is similar to the share of Pasifika employment in the economy as a whole. However, within the high emissions-intensity grouping, some industries are a larger source of employment than others. Meat manufacturing, other food manufacturing and road and rail transport are important sources that together account for two thirds of Pasifika employment in the high emissions intensity grouping. Pasifika workers are also over-represented in several heavy manufacturing industries (glass, polymer, non-metallic mineral and cement manufacturing). As these are relatively small industries, the

combined number of jobs held by Pasifika workers in these industries made up just 6% of total Pasifika employment in high emissions intensity industries.

Figure 4.4 Workforce ethnicity across industry groupings



4.2.1 Migrant workforce

Figure 4.5 shows the share of the workforce across the different emissions groupings that is comprised of either people in New Zealand on a temporary work visa or temporary student visa, or holders of a New Zealand resident visa. The high emissions intensity grouping has a lower share of migrant workers than the low emissions grouping.

However, across the high-emissions industries (Figure 4.6), there is a lot of variability in the share of the composition of the workforce, ranging from sheep and beef farming and deer farming (with a migrant workforce of 6% and 7% respectively), through to fuel retailing and other food manufacturing (with a migrant workforce of 35% and 37% respectively).

Figure 4.5 Migrant workforce across industry groupings

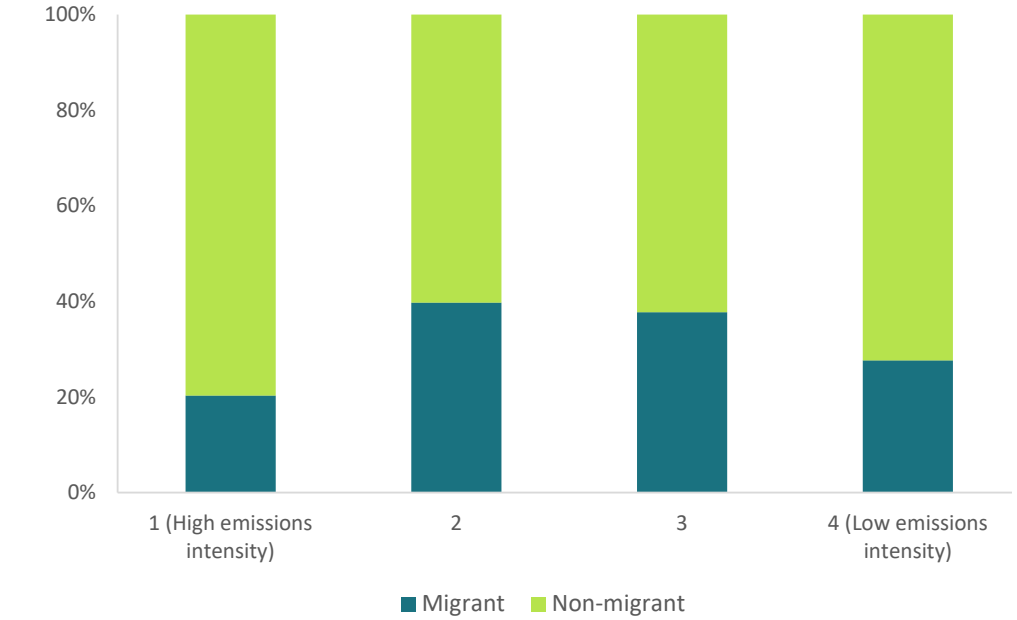
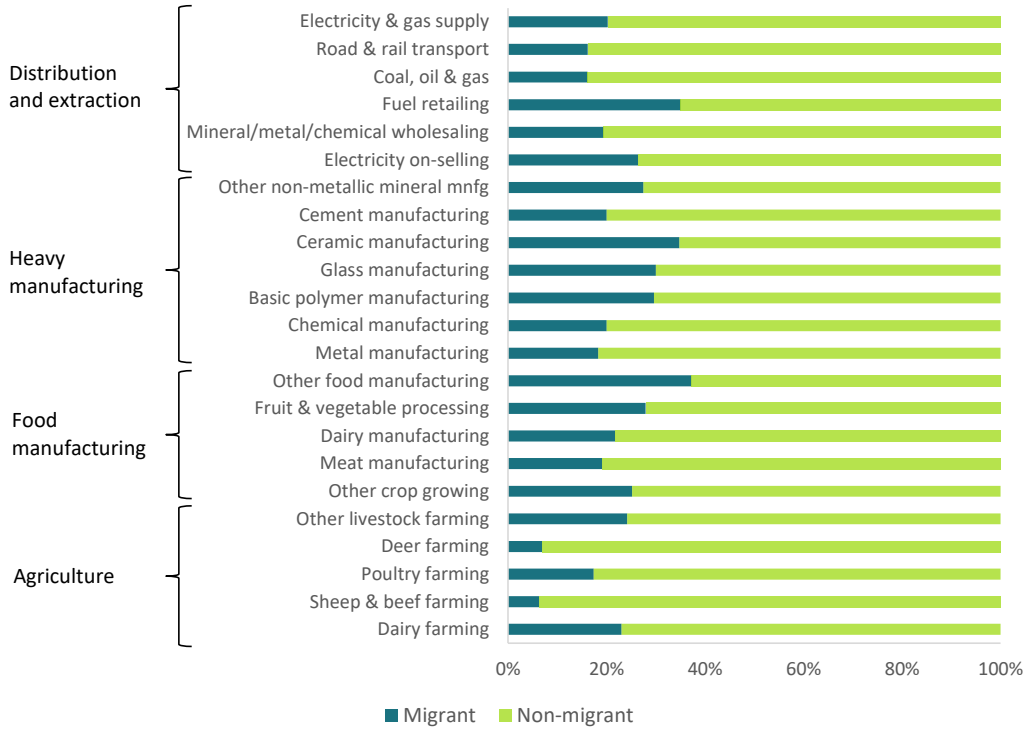


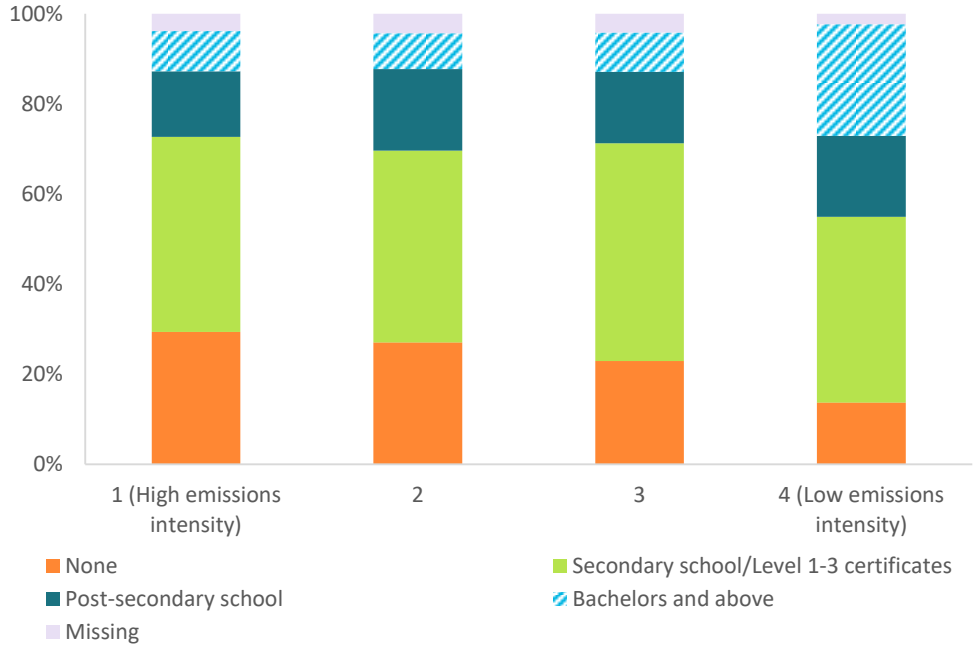
Figure 4.6 Migrant workforce in high emissions intensity industries



4.3 Workforce qualification levels

A clear pattern is also visible in the data on the highest qualification held by workers across the four emissions intensity groupings (Figure 4.7). The share of workers in high emissions intensity industries with no qualifications is 29%, which drops incrementally to 14% for workers in low emissions industries. At the other end of the continuum, workers with a Bachelors degree or higher accounted for less than 10% of each of the three higher emissions intensity industry groupings, but accounted for 25% of the workforce in the low-emissions intensity grouping. The share of the workforce with secondary school or level 1-3 qualifications is more consistent across the four industry groupings.[9]

Figure 4.7 Workforce highest qualification across industry groupings

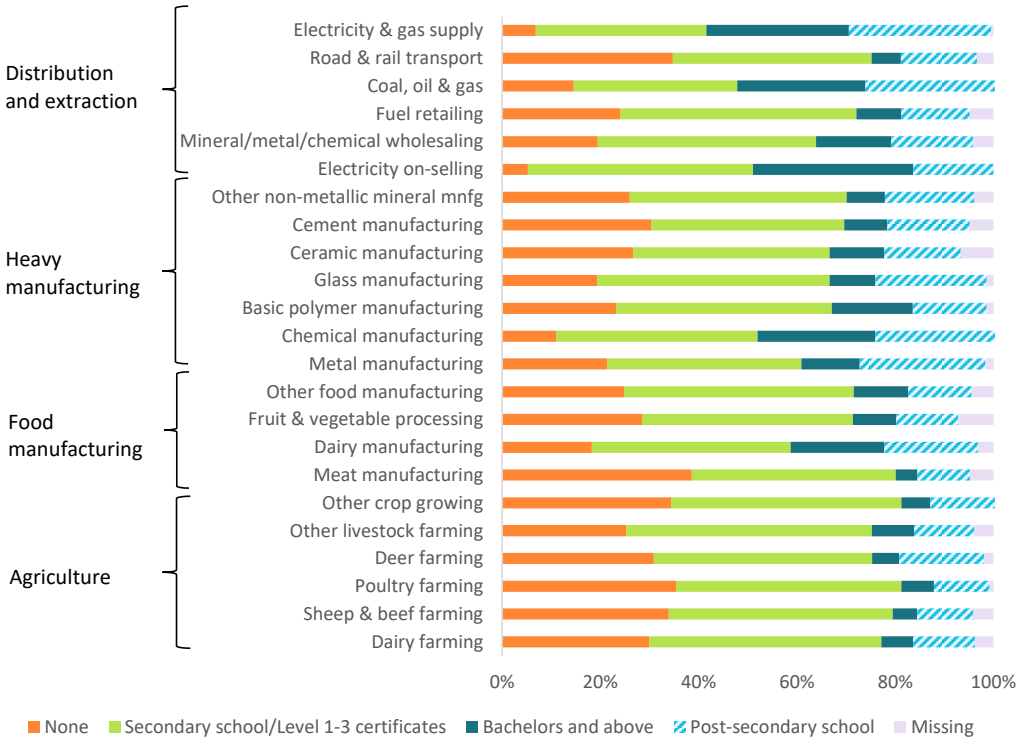


There is significant variability in the qualification levels across the industries that make up the high emissions intensity grouping. Relatively high shares of workers in the electricity and gas supply, coal, oil and gas, and chemical manufacturing industries have some form of tertiary qualification. By contrast, over three quarters of the workforce in

[9] The data presented for workforce qualification levels is based on those workers where a link could be established with Census data on highest qualification levels. No link could be established for a relatively high share of workers. For example, across the high emissions industry grouping the share of workers for which no link could be established ranged from 18% to 45%. Accordingly, the overall qualification levels across different industries could be over- or under-stated if the qualification levels of those workers where a link was not established is materially different to those workers that did link. In addition, among those workers where a link was established, a small share did not answer the Census question – these are recorded in Figure 4.7 and Figure 4.8 as 'missing'.

industries such as meat manufacturing, sheep and beef farming, and road and rail transport have a level 1-3 certificate or no qualification (Figure 4.8). As noted earlier, these figures do not capture the characteristics of working proprietors. Working proprietors feature prominently in some high emissions intensity industries including the sheep and beef farming industry and may have a different average qualification level to employees shown in Figure 4.8.

Figure 4.8 Workforce highest qualification in high emissions intensity industries

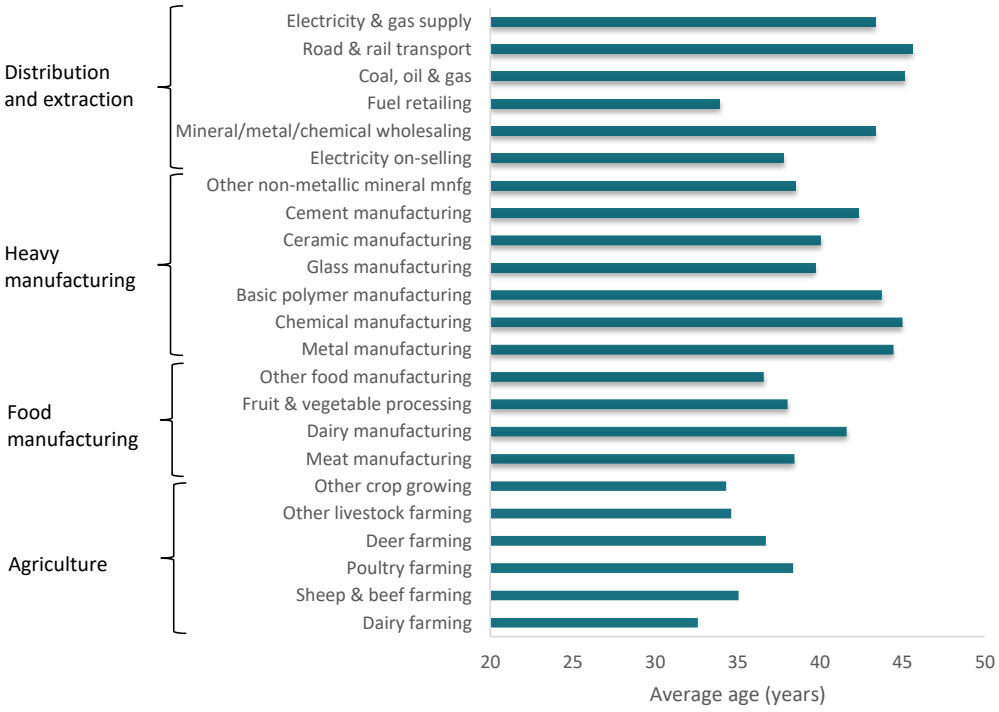


4.4 Workforce age

The average age of workers employed in the high emissions intensity grouping (38.5) was similar to the average for workers in low emissions industries (39), with the average age being younger in both medium emissions groupings.

There is significant variability in the average workforce age across the industries that make up the high emissions intensity grouping ranging from 32.5 for the dairy farming industry to 45.5 for the road and rail transport industry (Figure 4.9). Employees in high emissions intensity agricultural industries tend to be younger, while the workforce for most heavy manufacturing and distribution and extraction industries is older. As noted earlier, working proprietors (who are not included in this data) are an important source of labour for high emission agricultural industries and may have an older age profile than employees.

Figure 4.9 Workforce average age for high emissions intensity industries

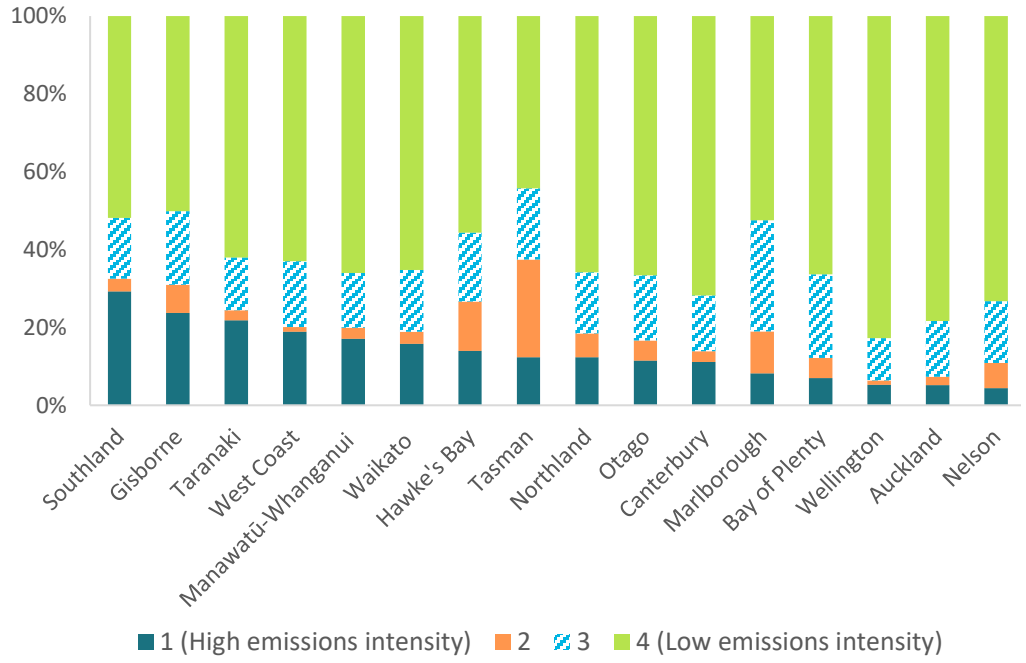


4.5 Regional employment distribution by emissions intensity

Figure 4.10 shows the distribution of workers by region for the four industry groupings. The results show that smaller regions without large cities tend to have a larger share of the workforce employed in emissions-intensive industries. In regions with a predominantly urban population, employment is concentrated in low-emissions industries which likely reflects the importance of the services sector in those cities.

For example, 29% of the workforce in Southland is employed in the high emissions intensity group of industries, while 52% is employed in low emissions industries. Just 5% of employment in the Wellington region is in the high emissions industry grouping, while 83% is in the low emissions grouping.

Figure 4.10 Regional distribution of workers across industry groupings



We also examined which specific high-emissions industries are important sources of employment for each region. However, reporting the industry-level employment on a regional basis was not always possible due largely to data confidentiality requirements (some industries have relatively low levels of employment in some regions, and for some high emissions industries, employment is concentrated in a relatively small number of firms). Accordingly the following analysis is based only on the employment data for those regions where the region accounted for a significant share of the industry's total employment.[10]

Figure 4.11 shows each incidence where a high emissions industry is a significantly more important source of employment at a regional level (i.e. a location quotient greater than 3) and the industry accounts for at least 0.5% of regional employment.[11] Accordingly, the figure captures those high emissions industries that are an important source of employment in the region (relative to the rest of New Zealand) and also account for a notable share of the region's total employment.

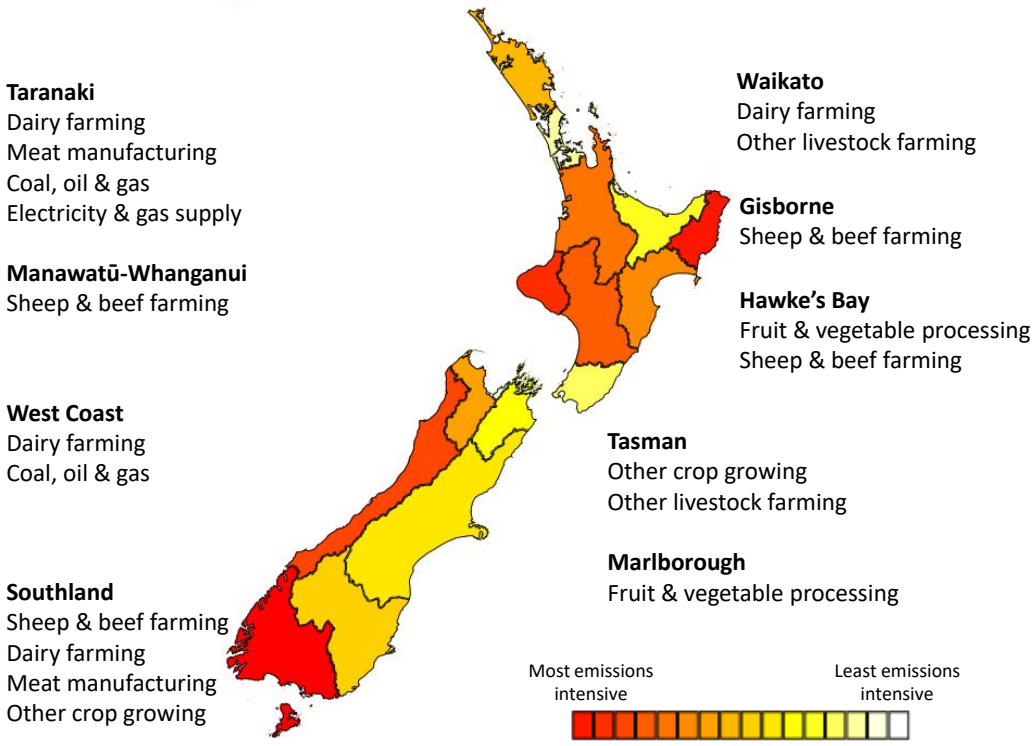
Key things to note from Figure 4.11 are the important contribution that agricultural industries, food manufacturing industries and coal, oil and gas make to employment in

[10] We calculated the employment in each region for each industry (E_{ir}) as well as the total employment for each industry (E_i) to calculate the region's share of the industry's employment (E_{ir}/E_i). For example, if an industry, I, with 100 employees had 10 workers working in region R, region R's employment share would be 10% of industry I's total employment. We then ranked each region by this share for each industry and released these shares for the top 3 regions for each industry to the extent possible given confidentiality rules.

[11] Data included in Appendix A.

provincial regions. In addition, the shading in Figure 4.11 shows the relative emissions-intensity of employment in each region based on the share of the workforce employed in high emissions intensity industries.

Figure 4.11 Important high emissions intensity industries by region



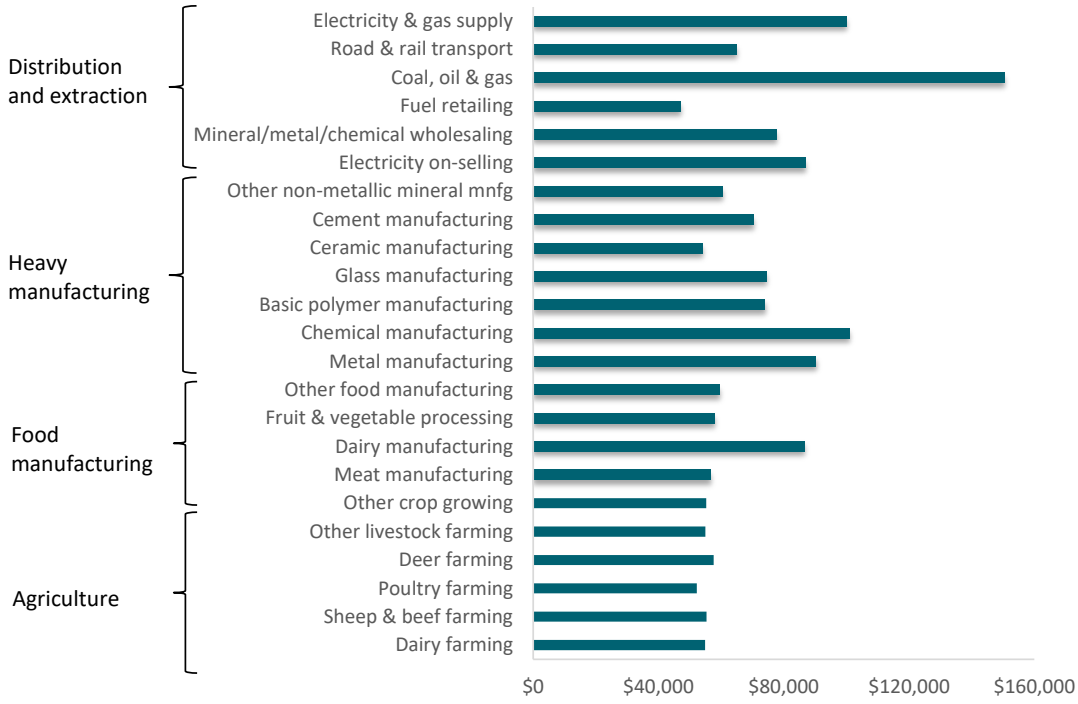
5 Employment characteristics

This chapter sets out the characteristics of the employment arrangements for workers depending on the emissions intensity of their industry. As with the previous chapter, the results are presented at an aggregate level for the four broad industry groupings presented in chapter 3. This is followed by examination of the employment characteristics for specific industries within the high emissions intensity grouping.

5.1 Average annual earnings

Average annual earnings for full time workers in high emissions intensity industries in 2017 were $69 650, marginally lower than the average for the group of low emissions industries ($70 950).[12] However, there is significant variability in the average earnings across the industries that make up the high emissions intensity grouping (Figure 5.1).

Figure 5.1 Annual earnings for full-time workers in high emissions intensity industries



[12] This measure is based on worker-job months where the worker is employed on a full-time basis. It is calculated using an 'equivalised' approach. This means we calculate the average monthly earnings for a worker-job in the industry, and then multiply the monthly earnings by 12. The benefit of looking at equivalised annual earnings is that it avoids the issue that some workers may work less than 12 months in their job, so taking an 'ordinary' average might give annual earnings lower than what a typical 12-month salary could look like in the industry.

Average earnings for agricultural industries and food processing industries (except dairy manufacturing) are around 20% lower than the average for the high emissions intensity group as a whole. By contrast, there are some highly paid industries in the heavy manufacturing and extraction and distribution industries – particularly metal manufacturing, chemical manufacturing, electricity and gas supply, and coal oil and gas.

5.2 Job starts, job ends and short spells

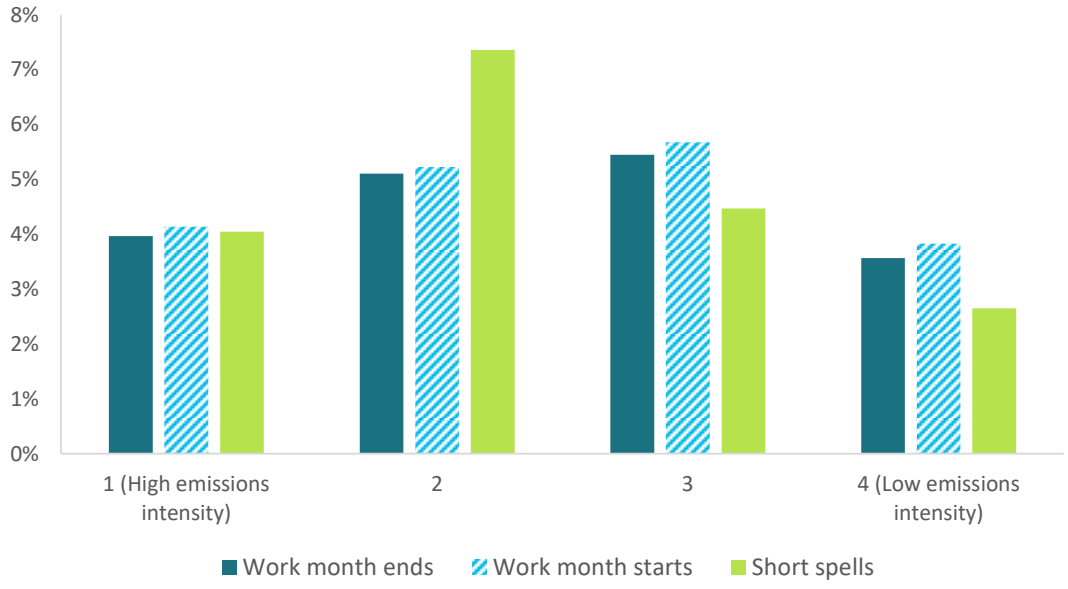
Figure 5.2 shows three sets of results for the industry groupings:

- the share of job months that were short spells, with short spells being defined as jobs with no "interior month" of employment (e.g., the job starts in one month and ends the following month);
- the share of job months that were job starts but were not short spells; and
- the share of job months that were job ends but were not short spells.

The worker starts and ends provide an indication of the rate of worker turnover within each industry grouping while the share of job months that were short spells gives an indication of the share of work within each industry that is undertaken on a temporary basis, such as seasonal work.

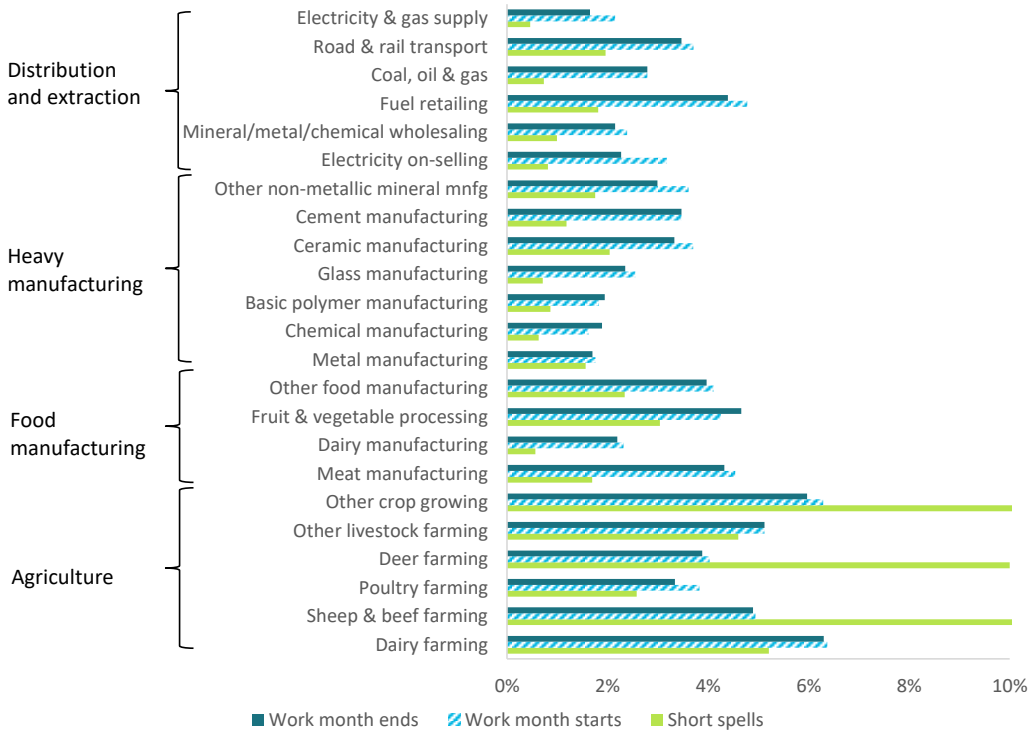
The aggregate results indicate slightly higher rates of worker turnover in more emissions-intensive industries, and a higher incidence of short spells. Short spells are particularly higher in the "medium-high" emissions grouping, which is likely driven by high volumes of seasonal work industries such as horticulture and fruit growing.

Figure 5.2 Employment characteristics across industry groupings



Within high emissions intensity industries, there are significantly greater shares of short spell employment in agricultural industries reflecting the prevalence of seasonal work in some industries (Figure 5.3).

Figure 5.3 Employment characteristics in high emissions intensity industries[13]



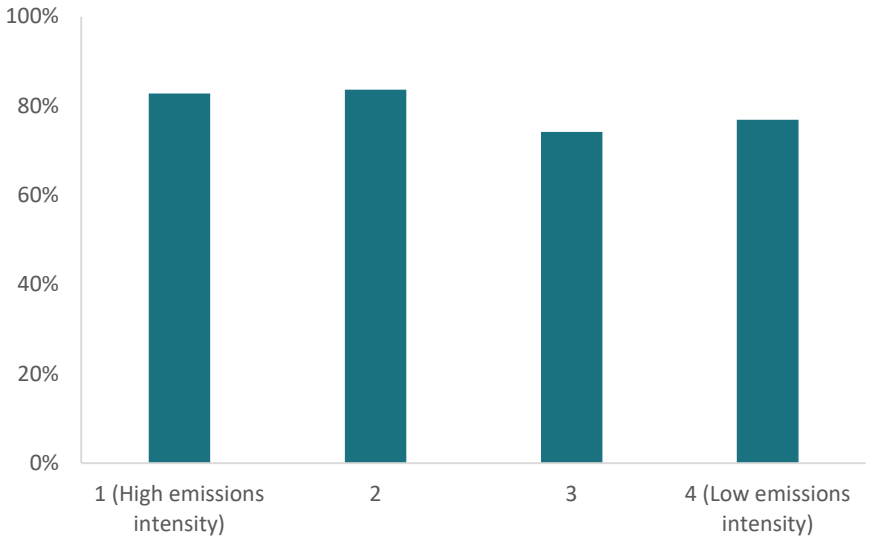
Agricultural industries and food manufacturing industries (except dairy manufacturing) tend to have a higher share of job months that are starts and ends which may indicate high levels of job churn in those industries. Industries characterised by very low shares of job months that are starts or ends (indicating particularly stable employment arrangements) include chemical, polymer and metal manufacturing.

5.3 Full-time and part-time work

Figure 5.4 and Figure 5.5 show the share of workers who report working full-time (for their main job, as reported in the 2018 census) across different emissions intensity groupings and for high emissions intensity industries. At the aggregate level, a greater share of workers in high emissions intensity industries (83%) reported working full-time than workers in the low emissions grouping (77%).

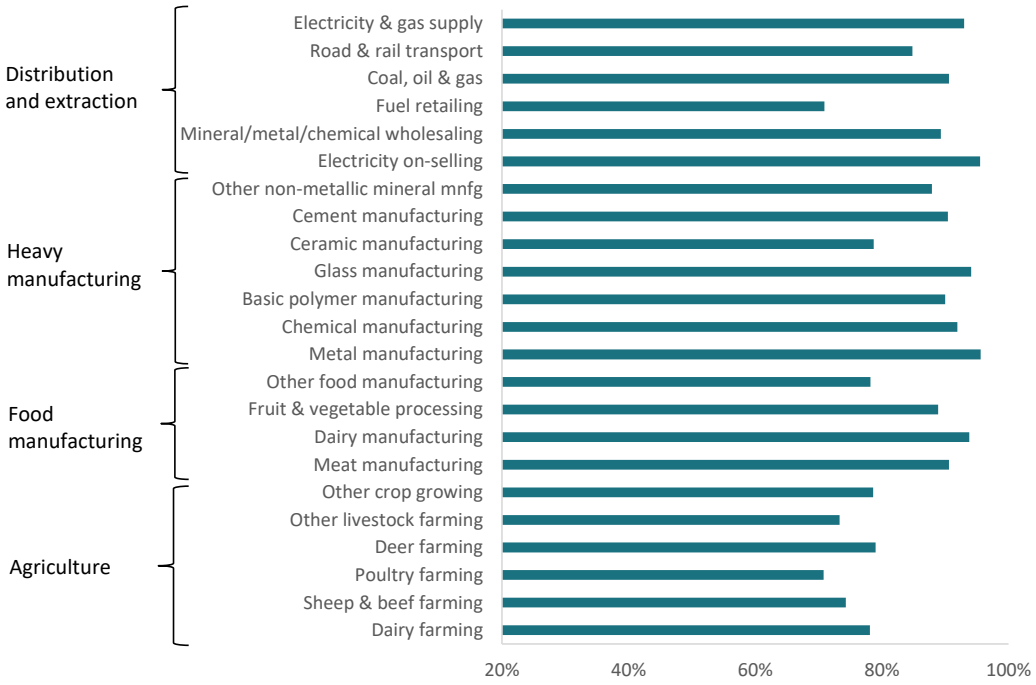
[13] The share of short spells for sheep and beef farming is 21%.

Figure 5.4 Share of employees working full-time across industry groupings



Across the high emissions (Figure 5.5) intensity industries, agricultural industries all had lower shares of full-time work than the average for high emissions intensity industries, while most industries, particularly heavy manufacturing, had higher shares of full-time work.

Figure 5.5 Share of employees working full-time in high emissions intensity industries



5.3.1 Hours worked for full- and part-time workers

Using 2018 Census data about workers' main jobs, we also examined the average number of weekly hours worked across the different emissions intensity groupings and for high emissions intensity industries. At the aggregate level, full-time workers whose main job was in the high emissions intensity industry grouping reported working a greater number of hours per week (46.7) in their main job than workers in the low emissions grouping (42). This is driven primarily by longer reported hours worked in some agricultural industries (particularly dairy farming, other crop growing, deer farming and sheep and beef farming)[14] and the road and rail transport industry.

Average weekly hours worked by part-time workers whose main job was in the high emission grouping (14.3) were slightly lower than those for workers whose main job was in the low emissions grouping (15.4).

[14] It should be noted that the Census was collected in the Autumn of 2018, with Census Day on 6 March 2018, which is at the end of the peak season for most agricultural industries. Hence, it is possible that workers' hours are based on peak season and that hours in other seasons may be reduced.

6 Firm characteristics

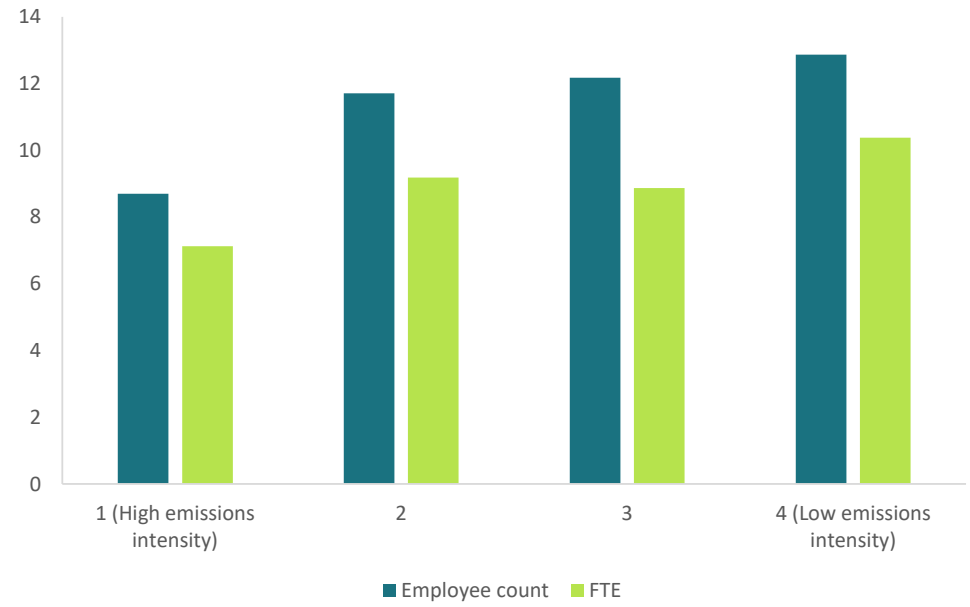
This chapter sets out descriptive data on the characteristics of firms depending on the emissions intensity of their industry.

6.1 Firm size

6.1.1 Employment

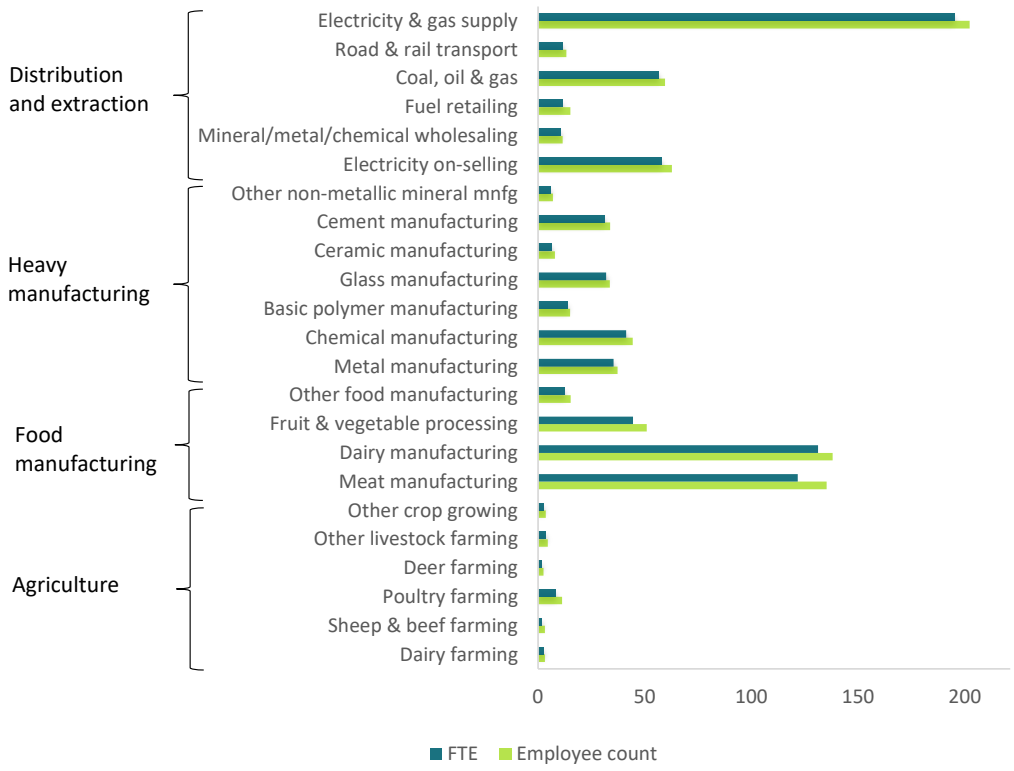
Figure 6.1 shows both the average employee count and the average number of full-time equivalent (FTE) [15] staff per firm across different emissions intensity groupings. On average, high emissions intensity firms employ fewer staff. This is driven by firms in agricultural industries which (apart from poultry farming) have very low employee numbers. Other types of high emissions intensity industries are more mixed in terms of the number of employees with dairy manufacturing, meat manufacturing and electricity and gas supply having the largest average firm size (Figure 6.2).

Figure 6.1 Average employee count and FTEs across industry groupings



[15] We use the measure of FTE as calculated by Fabling & Maré (2015). Since hours information is not available, this measure is based on the income reported for the employee and on the statutory minimum wage.

Figure 6.2 Average employee count and FTEs for high emissions intensity industries



6.1.2 Average sales and purchases

In order to establish a broader picture of firm size, we also examined the average annual purchases paid by firms in different industry groupings along with average annual sales. On average, firms in the high emissions intensity grouping had higher annual sales ($38 million) than firms in the low emissions grouping ($34 million), while annual purchases were similar for the two groupings. Due to data confidentiality requirements we are not able to report the sales and purchases data for individual industries within the high emissions intensity grouping.

6.2 Firm age

Figure 6.3 shows that on average, firms in the high emissions intensity grouping have been in operation for nearly two years longer than firms in the low emissions grouping. This is reasonably consistent with just four of the industries in the high emissions intensity group having an average age lower than the average for the low emissions group (Figure 6.4). Those industries that have younger firms on average are electricity on-selling, other food manufacturing, dairy manufacturing and other livestock farming.

Figure 6.3 Average enterprise age across industry groupings

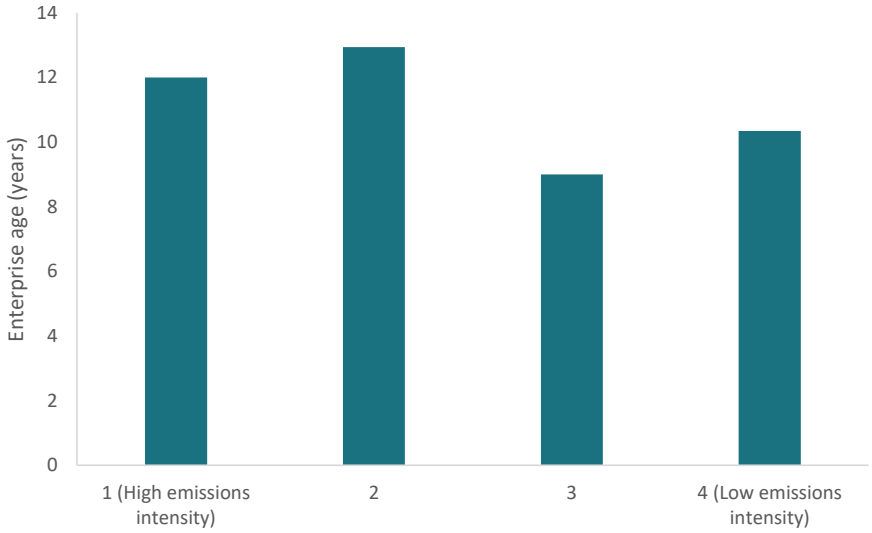
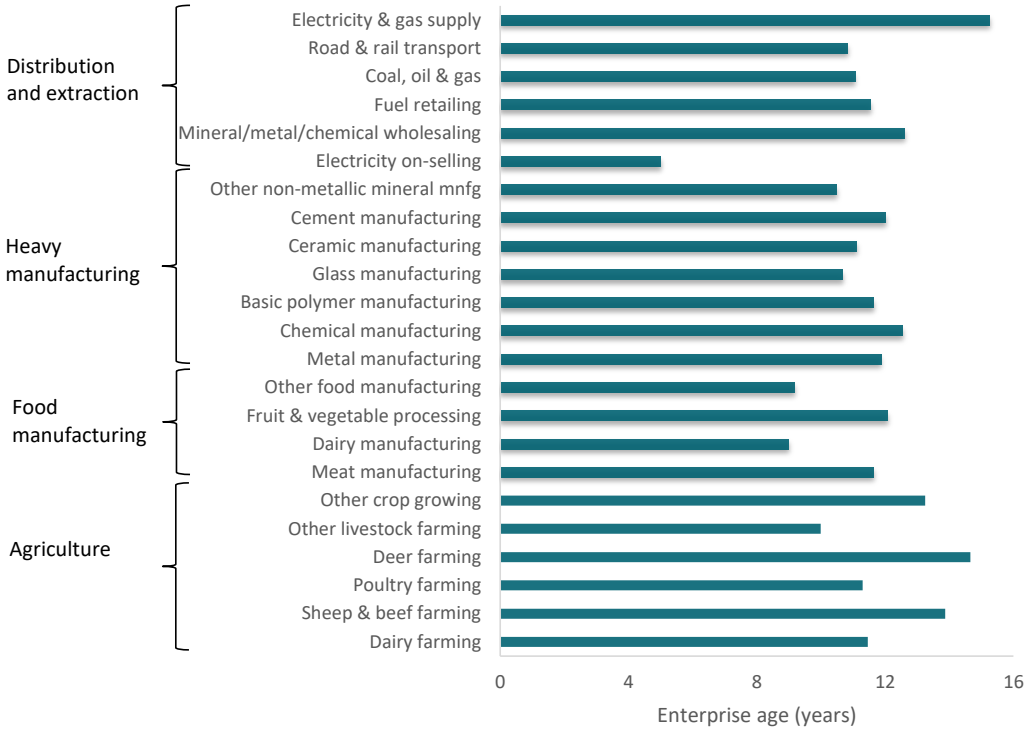


Figure 6.4 Average enterprise age for high emissions intensity industries



6.3 Firm births and deaths

Figure 6.5 shows the share of firms in the high and low emissions groupings that were newly established (births), ceased operating (deaths), or were continuers for the

financial years 2010 to 2016. The high emissions intensity grouping has a slightly higher share of firms that are continuers than the low emissions grouping. While the low emissions grouping has a higher share of firm births and deaths, the relative share of births and deaths was similar for both groupings, i.e., firm births typically accounted for between 70% and 75% of non-continuing firms in both emissions groupings.

Figure 6.5 Births, deaths and continuers for high emissions intensity and low emissions industry groupings, 2010 – 2016

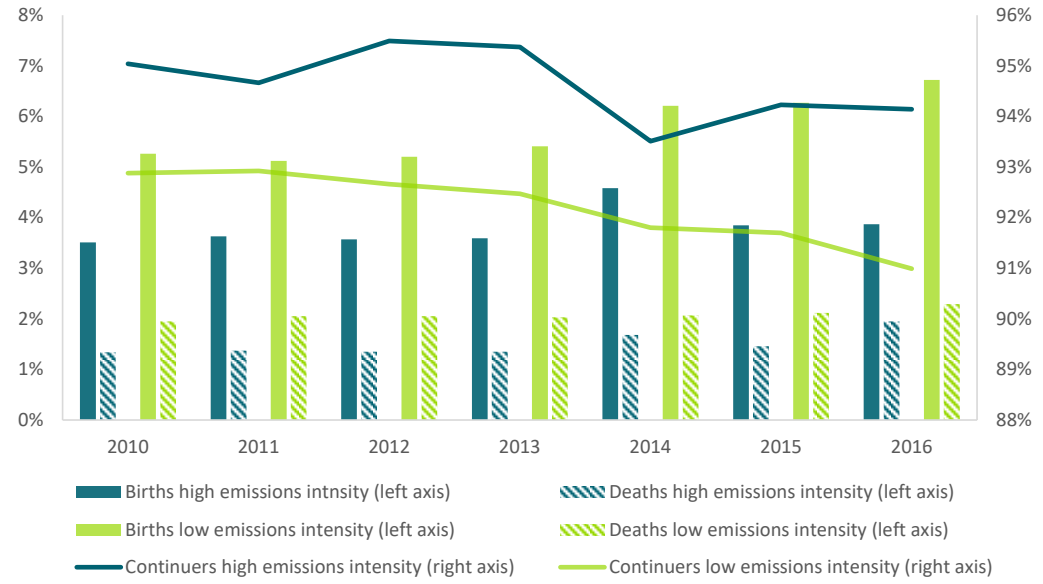
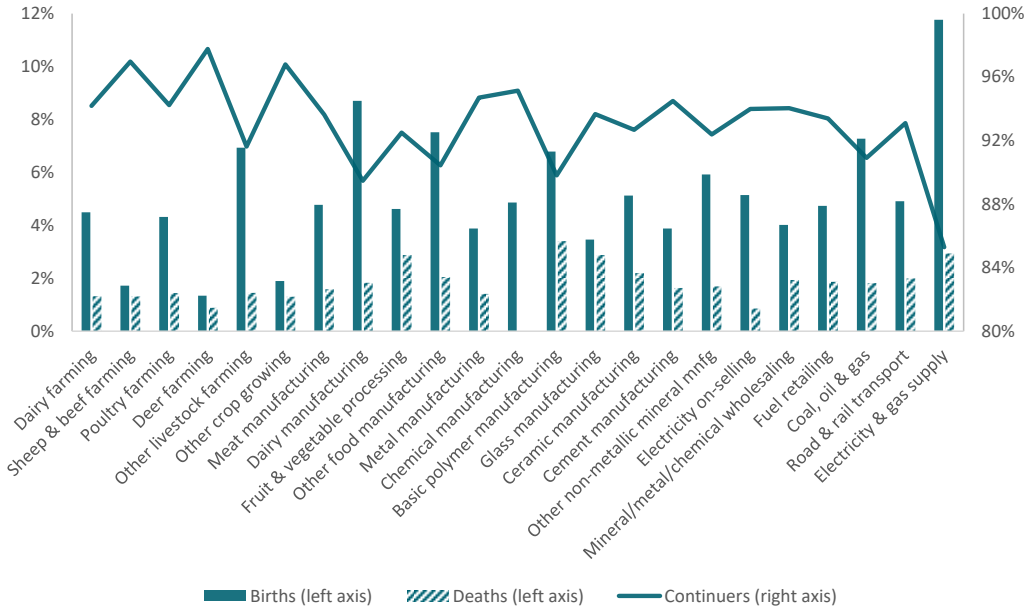


Figure 6.6 shows the firm births, deaths and continuers for high emissions intensity industries. The results are broadly similar across the industries, with the exception of some industries with relatively high shares of firm births (and correspondingly lower shares that are continuers). These include industries such as dairy manufacturing and electricity and gas supply which tend to have a small number of relatively large firms. Accordingly, a small number of new firms could significantly alter the average for the industry as a whole. For all industries, the share of firm births exceeded the share of deaths, although the share of births and deaths was similar for three agricultural industries (sheep and beef farming, deer farming, and other crop growing).

Figure 6.6 Births, deaths and continuers for high emissions intensity industries, 2016



7 Conclusions and discussion

Drawing on the results presented in the three preceding chapters, this chapter sets out some key conclusions and discusses the implications of the findings for policies to support workers, firms and regions as New Zealand transitions to a low-emissions economy.

7.1 Labour market implications

Key findings from the analysis of the characteristics of the workforce for high emissions intensity industries include:

- The workforce in high emissions intensity industries is male-dominated. This is evident across nearly all high emissions intensity industries and is particularly apparent in road and rail transport and in heavy manufacturing industries such as cement and metal manufacturing.
- Māori account for a higher share of employment in emissions-intensive industries than in low emissions-intensity industries driven primarily by a high share of Māori employment in sheep and beef farming, meat manufacturing and road and rail transport.
- Qualification levels are lower on average in high emissions intensity industries. Industries with particularly high shares of workers with no or low qualifications include sheep and beef farming, meat manufacturing and road and rail transport.
- The average age of employees in high emissions intensity industries is similar to the workforce for the economy as a whole, however there is significant variability across individual industries. Employees (excluding working proprietors) in high emissions intensity agricultural industries tend to be younger, while the workforce for heavy manufacturing industries, road and rail transport and coal, oil and gas is, on average, much older.
- Average earnings for high emissions intensity industries are on par with lower emissions industries. Within high emissions intensity industries there are some pockets of highly paid jobs while on average, jobs in high-emissions agricultural industries and food processing (except dairy manufacturing) are lower paid.
- High emissions intensity industries experience slightly higher rates of job churn (as measured by the share of worker-job months where an employee is starting or ending an employment spell), particularly agricultural industries. Industries characterised by particularly stable employment arrangements include chemical and metal manufacturing.
- Workers in agricultural industries are more likely to be working less than full-time whereas heavy manufacturing, electricity and gas supply and coal, oil and gas industries have higher shares of full-time work.

As the economy transitions, some workers may experience negative impacts such as job displacement and longer-term changes in demand for their skills as the economy shifts away from some emissions-intensive activities where abatement options are limited. The United Nations Environment Programme (2008) set out four key ways that the labour market will be affected as climate change regulation is enforced and economies are oriented toward greater sustainability:

- In some cases, additional jobs will be created, for example jobs relating to the manufacture of new lower-emissions products and services.
- Some employment will be substituted – shifting from fossil fuels to renewable energy sources, or from land filling and waste incineration to recycling.
- Certain jobs may be eliminated without direct replacement – as when packaging materials are discouraged or banned and their production is discontinued.
- Many existing jobs will be transformed and redefined as day-to-day skill sets, work methods, and profiles are transformed to take greater account of emissions and other environmental objectives.

The net effect of these changes will depend on the relative strength of these different trends and there is not yet a strong consensus as to the likely impact of the transition to a low-emission economy on jobs. Some studies have suggested that the transition will be a source of job growth with job gains exceeding job losses (Martinez-Fernandez et al. 2010). But even if the net effect is job positive, job displacement and reduced demand for certain types of skills will still occur for certain occupations.

Research in New Zealand and other jurisdictions shows that job displacement can be a hugely traumatic experience with significant impacts on wellbeing. In addition to the immediate short-term impact that displacement has on income, it also results in long-term wage scarring and puts a dent in longer term re-employment prospects (Hyslop and Townsend, 2017).

7.1.1 Impacts are likely to vary depending on the age of the workforce

The average age of the workforce for high emissions intensity industries is mixed, with some industries characterised by relatively young workers, while others have an aging workforce. Based on past experience, younger workers are more vulnerable to job displacement during downturns and shocks. For example, Maré (2018) finds that young people were particularly hard hit by the post-GFC labour market contraction, with a sustained decline in the employment rate for workers aged 15 – 24. Similarly, research examining the labour market impacts of natural disasters has also shown that young workers tend to be more heavily impacted (Chang-Richards et al. 2013). Policy measures to support younger displaced workers should focus on developing the longer-term education and skills that workers will need to be resilient to change throughout their working life.

While older workers may be less likely than younger workers to experience job displacement during a downturn or shock, domestic and international studies have

found that in the event of job loss, older workers tend to experience larger post-displacement difficulties (Chan and Stevens, 2001; Heisig and Radl, 2017; and Hyslop and Townsend, 2017). Particular challenges that may face older workers in the event of job displacement include skill obsolescence (i.e., skills becoming outdated over time) and having higher levels of job-specific human capital. Over their careers, older workers may work their way into a role that is very well matched to their skills and accordingly face greater difficulty than younger workers finding a job-match that aligns with their previous income (Heisig and Radl, 2017). Older workers might also have less flexibility to relocate for alternative employment opportunities owing to family commitments.

There are concentrations of older workers in parts of the manufacturing sector, road and rail transport and coal, oil and gas. Accordingly, in the event that firms in these industries become less viable in future, their workforce may experience particular difficulty regaining employment at an equivalent level. The OECD notes the importance of training guidance and counselling for older workers to identify relevant training options. Such training and counselling needs to be tailored to meet the needs of the age group in question. For instance, face-to-face guidance may be needed for some displaced workers who are not comfortable with online or phone guidance. It is also important for older workers to have the skills they have accumulated on the job identified and recognised before choosing to retrain (OECD, 2017).

7.1.2 Effective programmes to support workers to retrain and upskill will remain important

Over the course of the transition, demand for certain types of skills may stagnate or decline, while demand for other skills will increase. There is a considerable degree of uncertainty about how this future will unfold, but in the New Zealand context it seems reasonable to assume that we will see some or all of the following.

- Significant change in land-use including stable or declining rates of pastoral farming, increases in native and exotic afforestation and potential downstream opportunities from large-scale forestry (New Zealand Productivity Commission, 2018).
- Changes in farming towards lower-emission methods, and leveraging this into provision of know-how to other agricultural nations (New Zealand Productivity Commission, 2018).
- Changes in manufacturing methods, and changes in building and construction toward more energy efficient materials production and processes, and buildings with lower embodied carbon.
- Changes in the energy system, with significant investment in the construction and operation of new renewable generation.
- Changes in transport and waste management systems toward less use of fossil fuels and greater reuse and recycling of materials.
- Increased opportunities in innovation, science, research and the deployment of new technologies to support lowering emissions (Fankhauser et al. 2008).

The findings from this research have shown that there are large numbers of workers in emissions-intensive industries with low or no formal qualifications. For some of these workers, there may continue to be strong demand for their skills. However for other workers the transition may require upskilling or retraining. This signals a need for effective retraining and upskilling options, and the development of transferrable skills that are compatible with multiple roles. It also points to the importance of effectively monitoring emerging trends and making information on these readily available to businesses, workers, learners and education providers so that they can make decisions about what skills to invest in and support.

7.1.3 Labour market policy settings should be attuned to particular challenges faced by Māori workers

Māori account for a high share of employment in emissions-intensive industries – particularly those industries characterised by relatively low qualification levels. Of the high emissions intensity industries that were analysed in this research, the sheep and beef industry has the largest Māori workforce (both as a share of the workforce and in absolute terms). In future, this industry is likely to face pressures both as an emissions-intensive industry, and as incentives to shift to alternative land uses strengthen as prices in the Emission Trading Scheme rise.

Māori employees have historically fared poorly in transitions and economic shocks such as the economic reforms of the 1980s (Coleman, Dixon and Maré, 2005; Whitehead and Annesley, 2005; Te Puni Kōkiri, 2009). They have also weathered other significant impacts, such as the Christchurch earthquakes, less well than Pākehā workers (Reid et al., 2020).

Ultimately, the extent to which Māori workers are exposed to job displacement or reduced demand for labour in certain industries will depend on the types of change that firms undergo as New Zealand transitions to a low-emissions economy. However, given that Māori account for a high share of employment in high emissions intensity industry and have traditionally fared poorly in shocks and transitions, there is potential for the transition to a low-emissions economy to exacerbate existing inequalities for Māori. Accordingly, it is important that labour market policies, skills and education programmes and measures to support growth of low-emissions economic activity are effective in developing employment and business opportunities for Māori. Monitoring changes in employment patterns for sheep and beef farming, meat manufacturing and road and rail transport will be particularly important given the large numbers of Māori employed in these industries.

7.1.4 Employment characteristics vary across high emissions intensity industries

This research shows that high emissions intensity industries experience slightly higher rates of job churn (as measured by the share of worker-job months where an employee is starting or ending an employment spell), particularly agricultural industries. Some high emissions intensity agricultural industries also have significant shares of workers employed for short spells and relatively higher rates of part-time work.

There is some evidence to suggest these workers may be particularly vulnerable in the event of economic change related to the climate change transition. For example, in a study examining involuntary job loss in New Zealand between 2002 and 2009, Dixon and Maré (2013) find that employees with more years of service in their jobs were substantially less likely to be displaced than those with shorter tenure. Similarly, Taylor (2019) notes that temporary workers are particularly vulnerable to economic changes in rural areas.

However, in the event of a job displacement, workers with longer job tenure tend to experience substantially larger and more persistent wage reductions than those with lower tenure. The findings of this research indicate that longer job tenure is likely in industries such as chemical, polymer and metal manufacturing as these industries are characterised by low shares of job months where employment starts or ends. Accordingly, in the event of job displacement or industry contraction, workers in these industries may require additional support to find alternative employment that is a good match for their skills and experience.

7.2 Regional distribution of emissions-intensive firms and workers

In addition to the overarching need for a comprehensive set of measures to support displaced workers, an additional risk in the transition to a low-emissions economy is that certain regions or parts of the economy might be particularly exposed to displacement. For example, this research shows that the high emissions intensity workforce is concentrated in rural regions with specific industry concentrations varying region by region. The four regions with the highest share of their workforce employed in high emissions intensity industries are Southland, Gisborne, Taranaki and West Coast. Regions where the majority of the population is based in cities, such as Wellington, Auckland and Nelson have the lowest shares of employment in emissions-intensive industry.

7.2.1 Implications

The spatial dimension of emissions-intensive employment reinforces the need for Government to work closely with transition-exposed regions to develop a long-term approach to transitioning local economies and supporting the growth of transition-aligned industry.

Negative impacts associated with the decline of certain industries are likely to be more acute when they occur in remote rural regions with fewer alternative employment opportunities. For example, research on the impact of the closure of major freezing works in Hawke's Bay and Taranaki showed those located in more isolated rural areas were less able to respond to these economic shocks (Grimes & Young, 2009). In particular:

- A more temporary effect in an urban area (Whakatu in Hastings) versus a more permanent effect in a rural area (Patea), consistent with labour market benefits of agglomeration in denser urban areas.
- Those who became unemployed from the closure in Whakatu found it easier to match their skills to other jobs available in the urban area, and therefore were able to bounce back from the employment shock.
- Patea residents, not possessing an urban area within a reasonable distance, found it hard to source work locally, and therefore emigrated.

Similar issues are identified in research examining fossil fuel (coal) dependent communities in the United States. These communities often exhibit characteristics that act against a successful transition such as limited economic diversity, a reliance on a small number of large firms, and limited employment opportunities that aligned with the skills of former coal workers (Mijin, 2017).

The concentration of emissions-intensive employment in certain parts of New Zealand coupled with the challenges associated with declining industries in remote regions points to the need for policies that support new development pathways in regions where high-emitting industries are being scaled back or phased out. Experience from countries such as the United States and Germany suggests the need for a combination of both short term (e.g. targeted interventions to support displaced workers in the event of a closure that accounts for a significant share of local employment) and long term policies (e.g. to diversify regional employment and economic base such as expanding the service sector, promoting local entrepreneurship) to maintain strong local economies (Mijin, 2017).

7.3 Characteristics of firms in emissions-intensive industries

On average, firms in high emissions intensity industries are slightly older than those in low-emissions industries and this is reasonably consistent across each of the high emissions intensity industries.

On average, high emissions intensity industries are smaller (in terms of employees) than low-emissions industries driven largely by high emissions intensity agricultural industries. High emissions intensity industries are also more likely to have a single plant – again, this is particularly evident among agricultural industries.

Within the high emissions intensity grouping there are also some industries that on average are large employers, particularly meat and dairy manufacturing, and electricity and gas supply.

7.3.1 Implications

In the face of a transition, large firms may have a relative advantage over smaller firms that is derived from economies of scale and scope. Larger firms typically have more resources to respond to regulatory requirements and are in a better financial position to bear compliance costs (Bickerdyke & Lattimore, 1997). For example, analysis of the

European Union emissions trading scheme shows that the scheme's effectiveness has been strongest in larger firms indicating that larger firms have a greater ability to make the investments needed to reduce emissions (Dechezleprêtre et al. 2018). Similarly, analysis of firm survival rates following the Christchurch earthquakes finds that larger and older firms were less likely to exit indicating that these firms are more resilient to disruption (Fabling et al. 2014).

By contrast, smaller firms often cite financial capital to be a key barrier to reducing emissions or achieving other environmental objectives (Conway, 2015; Rizos et al. 2016). In addition, smaller firms are more likely than larger businesses to report that they lack the time, technical, and organisational resources to implement measures which might make them more resilient to climate change (Conway, 2015). This general lack of resources can act as a barrier to smaller firms investing resources in activities they perceive as non-essential (such as the greening of the business).

This analysis finds that on average, firms in high emissions intensity industries tend to be older than firms in low-emissions industries, but also smaller. The presence of numerous small firms in high-emissions industries (particularly agriculture) indicates that these firms may require additional support in order to successfully manage this transition; for example through adopting low-emissions technologies and farming practices.

However, smaller and younger firms may be more dynamic and opportunistic than larger firms, and during periods of transition or economic instability may be better placed to seize new opportunities (Conway, 2015). In addition, there is some evidence to suggest that small businesses value efficient resource usage more than larger businesses (Kerr, 2006). This may be because they have fewer resources than their larger counter-parts, and therefore have to budget their usage more carefully.

The creation of new firms is a key driver of job growth, and different types of businesses and entrepreneurship are likely to emerge through the different stages of the transition (Meehan & Zheng, 2015; Estrin el al., 2005). Accordingly, it is important that policies to support the adoption of low-emissions technologies and other policies to support firms to reduce emissions do not act as a barrier to the emergence of new entrants with potentially lower-emissions business models.

Irrespective of firm characteristics, an important factor in supporting firms to adapt through the transition to a low-emissions economy is to establish a stable policy environment where the longer term direction of travel is consistent and is clearly signalled. This helps to provide firms with certainty and allows them to plan and take decisions accordingly. Changes in policy should be signalled well in advance and where possible, should be introduced incrementally so as to allow affected groups time to adapt (New Zealand Productivity Commission, 2018).

7.4 Conclusion

The composition of the workforce varies significantly across high emissions intensity industries. The characteristics of workers that will be negatively impacted during the transition to a low-emissions economy will depend on the pace and nature of change that specific firms and industries undergo during the course of this transition.

This research provides some initial evidence of the groups of workers, firms and regions that appear most vulnerable to change during the transition to a low-emissions economy in New Zealand. However, it does not seek to predict the specific types of impacts that different groups will encounter. Making such predictions accuately is very difficult, and climate change impacts will occur in concert with other shocks and longer-term trends such as technological change and demographic change. This uncertainty calls for close monitoring and a degree of policy flexibility to respond to unexpected impacts where they emerge.

This study has also highlighted the importance of further research to build a better understanding of the types of changes that are likely to occur across the economy as policies to drive emissions reductions are introduced and strengthened. In particular:

- This research concentrated on detailed industry groupings at the expense of more detailed spatial analysis. More granular analysis at the spatial level (e.g. sub-regional analysis) would provide a much richer picture of the specific towns and communities where emissions-intensive firms and employment is concentrated.
- The research has provided some insights into the Māori workforce in high emissions intensity industries, however we were not able to consider the distribution of Māori-owned firms. Many Māori and iwi organisations already couple strong financial performance with a strong intergenerational focus and core values of guardianship and stewardship. These characteristics are likely to be a source of strength and resilience for Māori firms over the course of the transition to a low-emissions economy.
- The research looked at a relatively small number of variables relating to the characteristics of firms in emissions-intensive industries. Further research could investigate other variables, such as management capability, skills development and investment in research and development, and how those factors might affect firm vulnerability.

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Appendix A: Emissions-intensive industries

Abbreviated industry name	Australia New Zealand Standard Industry Classification
Dairy farming	Dairy Cattle Farming
Sheep and beef farming	Grain, Sheep and Beef Cattle Farming
Poultry farming	Poultry farming
Deer farming	Deer farming
Other livestock farming	Other livestock farming
Other crop growing	Other crop growing
Meat manufacturing	Meat and meat product manufacturing
Dairy manufacturing	Dairy product manufacturing
Fruit and vegetable processing	Fruit and vegetable processing
Other food manufacturing	Oil and fat manufacturing Grain mill and cereal product manufacturing Bakery product manufacturing Sugar and confectionary manufacturing Other food product manufacturing
Metal manufacturing	Basic ferrous metal manufacturing Basic ferrous metal product manufacturing Basic non-ferrous metal manufacturing Basic non-ferrous metal product manufacturing
Chemical manufacturing	Chemical manufacturing
Ceramic manufacturing	Ceramic product manufacturing
Cement manufacturing	Cement, lime, plaster and concrete product manufacturing
Other non-metallic mineral manufacturing	Other non-metallic mineral product manufacturing
Electricity on-selling	Electricity on-selling and electricity market operation
Fuel retailing	Fuel retailing
Electricity and gas supply	Electricity generation Electricity distribution Electricity transmission Gas supply
Mineral, metal and chemical wholesaling	Mineral, metal and chemical wholesaling

Coal, oil and gas	Coal mining Oil and gas extraction Exploration Petroleum refining and petroleum and coal product manufacturing.
Road and rail transport	Rail freight transport Rail passenger transport Road freight transport Road passenger transport

Appendix B: High emissions intensity industries that are significant source of regional employment

This table lists each incidence where a high emissions intensity industry is a significantly more important source of employment at a regional level (i.e. a location quotient greater than 3) and the industry accounts for at least 0.5% of regional employment (as shown in Figure 4.11).

Industry	Region	Share of regional employment (%)	Location quotient
Coal, oil, and gas	West Coast	2.5%	21.9
Other crop growing	Tasman	1.0%	10.9
Sheep and beef farming	Gisborne	16.1%	10.3
Coal, oil and gas	Taranaki	1.1%	9.6
Fruit & vegetable processing	Marlborough	1.7%	9.1
Fruit & vegetable processing	Hawke's Bay	1.5%	7.7
Other crop growing	Southland	0.5%	6.0
Dairy farming	Southland	7.5%	5.2
Sheep and beef farming	Southland	7.6%	4.9
Meat manufacturing	Southland	5.4%	4.7
Dairy farming	West Coast	5.8%	4.1
Dairy farming	Taranaki	5.3%	3.7
Meat manufacturing	Taranaki	4.3%	3.7
Electricity and gas supply	Taranaki	0.9%	3.7
Sheep and beef farming	Manawatū-Whanganui	5.5%	3.5
Sheep and beef farming	Hawke's Bay	5.4%	3.5
Dairy farming	Waikato	4.7%	3.3
Other livestock farming	Waikato	0.6%	3.3
Other livestock farming	Tasman	0.6%	3.2

New Zealand Government