HIDDEN LINKS, NEW OPPORTUNITIES
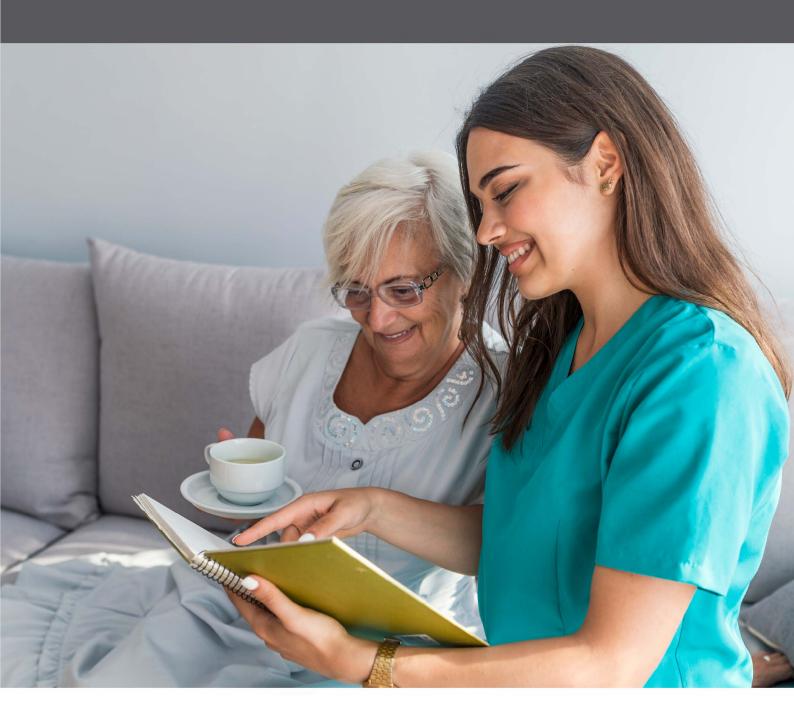
How big data and job clusters can improve the 1.2 million job matches in NZ each year

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αlphaβeta
strategy x economics

This paper was commissioned by Tertiary Education Commission and prepared by AlphaBeta. All information in this report is derived from AlphaBeta analysis using both proprietary research and publicly available data. Where information has been obtained from third-party sources, this is referenced in the footnotes.

Some of the data used in this report about jobs and skills across occupations, industries, and regions were drawn from Burning Glass Technologies.

The Tertiary Education Commission gratefully acknowledges the work of the Foundation for Young Australians, through their *'New Work Order'* report series. Concepts in this report were originally explored in the Foundation for Young Australian's report *'The New Work Mindset: 7 new job clusters to help young people navigate the new work order' (2016).*

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FOREWORD

The New Zealand education and employment landscapes are changing.

Historically we have focused on an education output to realise an employment outcome. As times are changing, the skills required by our labour market are challenging to identify and often develop or diminish faster than the market can keep pace.

We often talk about skills; the ones that are currently in demand, or that will be in the future. Generally these skills are at a high level, or are so technically specific that they are quickly obsolete as technologies, business processes or other factors shift. Understanding skills and skill requirements to meet the actual needs of industry is difficult and complex. However, we do recognise that there is a baseline of transferability that is not always obvious.

You often hear that businesses struggle to find staff with the right skills; they just want people who can 'hit the ground running'. For prospective employees to do this, they need the ability to communicate to the employer the right mix of skills, attitudes and capabilities. The employer also needs to be able to recognise, and have confidence in, the skills being offered.

In the absence of reliable, trustworthy information and support this becomes more difficult for everyone involved. The cost for an employer of a 'bad hire' can be significant. Being unable to market their skills effectively will potentially cost a prospective employee.

As the government agency responsible for careers, the Tertiary Education Commission (TEC) is tasked with supporting all New Zealanders with information, tools and investment to have the skills, capabilities and the right training opportunities to have a sustainable income for as long as they choose.

To achieve this, we need to shift the conversation away from focusing solely on jobs. Using aggregated 'big data' from what employers are specifically asking for in their job advertisements, this clusters approach does just that. It provides new linkages and reflects the skills that are actually valued by employers, and where those skills can be developed.

This discussion paper has been developed through the TEC led Careers System Strategy. We can't predict the scale, impact or breadth of the changes to the education and employment landscape but we can start the conversation on change.

Tim Fowler

Chief Executive,
Tertiary Education Commission

1.2 million

workers in NZ start a job each year. It's important to get these matches right

JAN 01

Jobs are more related than we think. On average, a person trained for **1 job** is portable to **12 other jobs**

There are
6 job clusters
in New Zealand

Inventors

NZ

Operators

Engagers

Clusters
are groups of jobs requiring similar skills

Fast growth: Inventor jobs are growing at 2.7% per year to 2023

Portability: The average **Operator** has skills relevant to 10 other Operator jobs and 2 jobs outside its cluster

Top skills: Engager jobs demand sales (**36%** of all cluster job ads), service (**19%**), and communication (**32%**) skills

We can use this to...

Help employers address
skills shortages

Guide young people to begin work in their dream industry

Empower workers with more opportunities and new options

1.EXECUTIVE SUMMARY

Around 1.2 million people in New Zealand start a new job each year and matching their skills with the right role can be a challenge.[1] A substantial portion of workers in New Zealand also appear to be churning through jobs – recent labour market snapshots show that each year between 2013 and 2016, one in eight employees had been in their jobs for two months or less.[1] This high turnover increases the importance of making good matches between workers and employers.

This report seeks to improve matching in New Zealand's highly dynamic labour market. Using big data to uncover hidden links between jobs, it provides valuable new insight to help workers and students, as well as their employers and educators, to uncover new career paths and work opportunities. By analysing a data set of unprecedented scale, we find surprising similarities in the skill profiles of occupations in New Zealand, which altogether can be grouped into six novel job clusters. The findings of this report benefit workers and students in making improved study and work choices, but they can also help employers in finding suitable workers faster to ameliorate skills shortages. Lastly, the findings offer a fact base for policymakers when assessing how workers can transition from declining industries into those with strong jobs growth.

The challenge of a dynamic labour market in NZ

Labour markets, in New Zealand and around the world, are highly dynamic. For many workers, it is normal today to change jobs and careers frequently. In New Zealand, around four out of 10 employees have been in their current role for 12 months or less.[1] Short job tenures are even more common among young people in New Zealand: six out of 10 employees aged between 20 and 29 have been in their current role for less than a year. Workers who change jobs often switch to entirely new industries. On average, more than half of all new hires in the US and UK – across all age groups – have previously worked in a different occupation or industry.[2] While comparable data is not immediately available for New Zealand, career switches are likely to be similarly common across developed economies.

Dynamic labour markets can be challenging to navigate. A good match between an employee and a job improves a worker's productivity, job satisfaction, and their proclivity to invest in learning.[3] Good matches also tend to drive overall economic growth.[4] However, high job turnover can sap an employer's resources for recruitment and training.

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[1] Stats NZ Household Labour Force Survey (HLFS) 2018.

[2] See: Federal Reserve Bank of San Francisco. 2012. *The Industry-Occupation Mix of US Job Openings and Hires*. Available at: https://www.frbsf.org/economic-research/files/wp12-09bk.pdf. European Economic Review. 2016. *The extent and cyclicality of career changes: evidence from the UK*. Available at: https://www.sciencedirect.com/science/article/pii/S0014292115001464.

[3] Centre for Economic Performance. 2003. *Aggregate Growth and the Efficiency of Labour Reallocation*. Available at: http://eprints.lse.ac.uk/20036/1/Aggregate_Growth_and_the_Efficiency_of_Labour_Reallocation.pdf.

[4] Ibid.

There are signs that New Zealand can do better when it comes to labour market matching. One in eight workers have been in their job for two months or less, suggesting that many workers in New Zealand are churning through jobs – a potential sign that workers' skills and roles may not always be fitting well.[5] Another signal of matching inefficiency is that job vacancies in New Zealand have increased faster than the unemployment rate has fallen in the years since 2009.[6]

As the New Zealand economy evolves, shedding jobs in some industries and gaining new ones in others, the need to optimise matching becomes ever more urgent. New technology in the workplace will continue to change both the mix of jobs in New Zealand and the tasks and activities that workers perform. For example, automation and artificial intelligence have begun to transform every job in every industry, leading companies to increase the use of machines for some of the most repetitive routine tasks.

Based on an analysis of more than one million online job ads, employment trends and skill profiles in New Zealand, this report provides guidance on how to cope with dynamism in the local labour market and improve its matching efficiency. The key finding: jobs in New Zealand, even when in seemingly unrelated occupations, have more in common than people may think. The core skills demanded by employers often overlap, meaning that a range of occupations – be it a chef, mechanic, farm manager or lawyer – share a surprising number of skills. This knowledge widens the talent pool: workers from seemingly unrelated industries may have a strong foundation of skills and may require only a small amount of additional training to fill a high-demand job.

Understanding the hidden similarities in skills that underpin the occupations in New Zealand can help to address several labour market challenges. Policymakers can harness the data on skill portability to help workers better transition away from areas of job decline and into growth opportunities. Employers can use the analysis to better identify potential candidates when faced with skills shortages. Finally, young people and their educators can find guidance in these findings on how jobs are related to better plan and launch their careers.

Report in brief

How big data highlights common skills between jobs

This report takes a fresh approach to facilitate the matching between workers and jobs in New Zealand by using big data to reveal the preferences and demands of employers in New Zealand. Its main objective is to show that workers can use their skills across many occupations, not just within a narrow set of jobs within one industry.

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[5] Stats NZ Linked Employer-Employee Data (LEED) 2013-2016.

[6] See for example research by the Reserve Bank of NZ on matching efficiency over the past few years: https://www.rbnz.govt.nz/-/media/ReserveBank/Files/Publications/Bulletins/2012/2012dec75-4cgg.pdf. In addition, the NZ government has measured the shift in the so-called Beveridge Curve, which illustrates the relationship between unemployment and the job vacancy rate. Since 2009, the curve has shifted outwards in NZ, suggesting that the unemployment rate has not fallen as quickly as job vacancies have increased, or that the labour market's matching efficiency has declined. Further details: http://www.mbie.govt.nz/info-services/employment-skills/labour-market-reports/jobs-online/jobs-online-quarterly-report-march-2018.

The six job clusters in New Zealand

Taking the approach of analysing skill requirements in different occupations revealed that New Zealand's labour market can be divided into six main job clusters.[7] These are 'Inventors', 'Organisers', 'Operators', 'Healers', 'Engagers', and 'Crafters' (Exhibit 1):

- **'Inventors':** people with technology and business skills, alongside creativity and problem solving.

- **'Organisers':** people with service-oriented and administrative skills.

- **'Operators'**: people with manual skills, good communication skills and a positive attitude.

- **'Healers':** people with caregiving expertise and some administrative and corporate skills.

- **'Engagers':** people with sales skills, combined with deep interpersonal skills.

- **'Crafters':** people with sophisticated industrial skills and organisational skills.

Each cluster is underpinned by different core skill requirements. For instance, one in three job ads for the 'Engagers' demand sales skills and communication skills, and one in five demand customer service skills. In contrast, 39 per cent of 'Inventor' job ads ask for communication skills, around one in five ask for project management skills, and one in ten ask for problem solving.

Exhibit 1

According to the skills requested by employers in >1 million online job advertisements, New Zealand has 6 main job clusters

We applied a clustering algorithm to online NZ job ads to group occupations which shared similar skills. Our analyses reveal 6 main job clusters:

Creative service workers requiring deep domain expertise, e.g.:
Solicitors | Scientists | Architects | Construction managers | Farm managers

Coordination services requiring accurate procedural work and interpersonal skills
Real estate agents | Secretaries and clerks | Event organisers | Accountants | Archivists

Manual work requiring strength, dexterity, or competency with machinery
Drivers | Glaziers | Brick layers | Machine operators | Forestry workers | Farm workers

Medium or higher skilled technical and artisanal work, e.g.:
Mechanics | Aircraft maintenance engineers | Boat builders | Chefs

Wellbeing services requiring sensitive personal skills
Medical professionals | Veterinarians | Social workers | Pharmacists | Occupational therapists | Aged Care Workers

Leisure services and sales requiring outstanding interpersonal engagement, e.g.:
Waiters | Gallery, museum, and tour guides | Telemarketers | Sales assistants

SOURCE: Based on a k-means clustering analysis using Burning Glass data from 2014-2017. The found statistical support for 6 large clusters and several smaller clusters, which we manually merged with an appropriate large cluster.

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[7] Real-time job market data from Burning Glass 2014-2017, accessed by AlphaBeta in May 2018.

The growing employer demand for information, creativity, and caregiving

- **The current services economy:** Not surprisingly, creative services workers ('Inventors') and people with coordination services skills ('Organisers') form the backbone of New Zealand's service-based economy. 'Inventors' form the largest cluster, with around 620,000 workers, followed by around 580,000 workers in the 'Organisers' cluster.[8] Together, these two clusters represent about half of the total workforce.

- **The future economy will require more creativity and caregiving:** 'Inventors' will likely remain dominant in the future. The analysis shows that they form the fastest growing worker group, with expected growth of 2.5 per cent per year over the next five years, followed by 'Healers' whose cluster is expected to grow at 2.2 per cent per year.[9] The importance of these two clusters point towards a future where skills relating to information, creativity, and caregiving are paramount.

- **Which jobs will require people with such skills?** The data indicates that 'Inventors' find solid job opportunities in occupations including engineering, software programming, and business analysis, which are lines of work projected to grow around 5 per cent per year until 2023. 'Healers' could find suitable employment as physiotherapists, midwives or nutritionists, which are also expected to grow at about 5 per cent per year until 2023.[10]

The potential opportunities that clustering analysis reveals for New Zealanders

The finding that six broad job clusters in New Zealand require a high degree of similar skills can significantly expand the career opportunities of workers.

- **One job helps to prepare workers for 12 others:** On average, working or training in one job helps to acquire skills for 12 other jobs. For example, the average individual in the 'Operators' cluster has skills that would enable them to transition into 10 roles within their cluster and two roles outside their cluster.

- **Understood well, portability can help workers move between jobs:** Knowing the extent to which skill sets are portable can help workers find new opportunities outside of their experience and work history. This is useful for workers who may find their current career opportunities limited by their declining industry or who decide to embark upon a new line of work. Conversely, employers can use the same analytical framework to source workers to fill jobs experiencing a shortage in talent.

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[8] Stats NZ Household Labour Force Survey (HLFS) 2018.

[9] Ministry of Business, Industry, and Employment (MBIE) 2018 estimate and AlphaBeta analysis

[10] MBIE 2018 estimate and AlphaBeta analysis

1. THE CHALLENGE OF A DYNAMIC NZ LABOUR MARKET

1.1. Switching jobs is common in New Zealand and globally

New Zealand's labour market of 2.5 million workers is highly dynamic, much like other developed economies (Exhibit 2). Some four out of 10 workers across the economy have been in their job for a year or less.[11] Short tenures are even more common among young workers: six out of 10 New Zealanders between 20 and 29 years of age have been in their role for a year or less.[12]

Many workers who switch jobs also switch careers and move into an entirely different occupation or industry. For example, in the UK every second person who started a new job between 1993 and 2012 worked in a different occupation or industry immediately prior to the job change.[13] In the US, 55 per cent of people who were newly hired between 2005 and 2011 came from a different industry and occupation.[14]

Exhibit 2

Labour markets, in New Zealand and around the world, are highly dynamic

In New Zealand

Job tenure in NZ
% of workers who have been in their role for 12 months or less[4]

4 out of 10 workers in NZ have been in their jobs 12 months or less

6 out of 10 workers in NZ aged 20-29 have been in their jobs 12 months or less

...and internationally

Job switching in UK[1]
% of new hires who are switching industries & occupations

50% 50%

■ Workers who change employers same industry or occupation
■ Workers who change employers change industry or occupation

Job switching in US[1]
% of new hires who are switching industries & occupations

55% 45%

■ Hires staying within same industries & occupations
■ Hires who are changing industries & occupations

Source: [1]Carrillo-Tudela et al. (2016) The extent and cyclicality of career changes: evidence from the UK. European Economic Review. [2] https://www.frbsf.org/economic-research/files/wp12-09bk.pdf. [3]Adapted and interpreted from Silverstone and Bell (2011) Gross Labour Market Flows in New Zealand. [4]Stats NZ Household Labour Force Survey (HLFS) 2018.

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[11] Stats NZ Household Labour Force Survey (HLFS) 2018.

[12] Ibid.

[13] See: Federal Reserve Bank of San Francisco. 2012. *The Industry-Occupation Mix of US Job Openings and Hires*. Available at: https://www.frbsf.org/economic-research/files/wp12-09bk.pdf. European Economic Review. 2016. *The extent and cyclicality of career changes: evidence from the UK*. Available at: https://www.sciencedirect.com/science/article/pii/S0014292115001464.

[14] Ibid.

1.2. The dynamic labour market is a challenge

Highly dynamic labour markets can be a challenge for an economy. Matching a worker with a job is one of the most important functions of a labour market.[15] A good match can improve a worker's job satisfaction, learning investment and productivity.[16] Good labour market matches typically also have a positive impact on overall economic growth.

Every year, 1.2 million workers start a new job in New Zealand.[17] While some of these job starts are related to seasonal surges in demand for agriculture and hospitality workers, the number of workers that need to find suitable work all year round is still substantial.[18] There is emerging evidence that New Zealand's ability to match workers and jobs can be improved. Over each of the four years leading up to 2016, some one in eight workers have consistently been in their job for only 2 months or less, implying high rates of churn for some workers.[19] Moreover, since 2009, the unemployment rate has not fallen as quickly as the increase in job vacancies – a common indication of matching inefficiency.[20]

New technology in the workplace will likely change both the mix of jobs in New Zealand and the activities performed within jobs, as it promises to do to other advanced economies. For example, automation and artificial intelligence loom as transformative forces that are set to impact jobs in every industry, as machines have begun to take over some of the most repetitive routine tasks at work.[21] This will liberate most workers to spend more time on tasks that require more uniquely human skills, such as creativity and problem solving, but it will also lead some workers to involuntarily change jobs. As the economy continues to evolve, shedding jobs in some industries and gaining new ones in others, frequent job and career switches will likely remain a feature of New Zealand's labour market.

Many different groups have a stake in the matching process (Exhibit 3). Students need to make smart education choices to navigate various role, job and career changes. People in the workforce need to better understand which current and future skills they need to find sustainable employment – and adjust their training needs accordingly. Education and training institutions in New Zealand need to respond to these changing learning needs and foster general skills that are valid across numerous

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[15] MBIE (2015), *Special Feature: Beveridge Curve in New Zealand*. Available at: http://www.mbie.govt.nz/info-services/employment-skills/labour-market-reports/jobs-online/special-feature-beveridge-curve-in-new-zealand/jobs-online-beveridge-curve.pdf/view. See page 5 for human capital investment by individuals.

[16] Centre for Economic Performance. 2003. *Aggregate Growth and the Efficiency of Labour Reallocation*. Available at: http://eprints.lse.ac.uk/20036/1/Aggregate_Growth_and_the_Efficiency_of_Labour_Reallocation.pdf.

[17] Stats NZ Linked Employer-Employee Data (LEED) 2016-2017. Matches as a proportion of total workforce are highest in the agriculture and hospitality industries, and in the Bay of Plenty and Gisborne/Hawke's Bay, suggesting a heightened influence by seasonal work.

[18] Stats NZ Workers accessions, Linked Employer-Employee Data (LEED) 2013-2016.

[19] Stats NZ Linked Employer-Employee Data (LEED) 2013-2016.

[20] See for example research by the Reserve Bank of NZ on matching efficiency over the past few years: https://www.rbnz.govt.nz/-/media/ReserveBank/Files/Publications/Bulletins/2012/2012dec75-4cgg.pdf. In addition, the NZ government has measured the shift in the so-called Beveridge Curve, which illustrates the relationship between unemployment and the job vacancy rate. Since 2009, the curve has shifted outwards in NZ, suggesting that the unemployment rate has not fallen as quickly as job vacancies have increased, or that the labour market's matching efficiency has declined. Further details: http://www.mbie.govt.nz/info-services/employment-skills/labour-market-reports/jobs-online/jobs-online-quarterly-report-march-2018.

[21] AlphaBeta (2017), *The automation advantage.* Available at: http://www.alphabeta.com/wp-content/uploads/2017/08/The-Automation-Advantage.pdf.

jobs. Employers need to understand how they can access larger talent pools to fill vacancies, develop beneficial skills within their current staff and avoid skill shortages. Government agencies also have a role to play: by providing information, tools and resources to make education systems and employment services more effective in supporting worker transitions.

Exhibit 3

Different groups have a stake in improving the 1.2 million new jobs started each year in the New Zealand labour market

The dynamism is a challenge: each year **1.2 million workers** start a new job in NZ.

The problem: Over the past decade, RBNZ and MBIE find that best matches are not being made.[1]

Workers and students
- Young people need to navigate their career pathway through education and multiple changes in jobs, and make smart study and work choices
- Workers need to better understand their skill overlap and gaps and how to transition from declining occupations

Government
- Government needs to ensure information and incentives that encourage the teaching of key, commonly-demanded skills
- Government needs to help to ensure programs support workers in declining occupations to best transition

Employers
- Employers need to access the largest possible talent pool to satisfy their labour needs
- Employers also stand to benefit from understanding how diverse job histories might be relevant to filling areas of skill shortage

Educators
- Educators should foster skills that have broad applicability and are critical to many jobs
- Educators need to encourage a mindset for ongoing learning and skill acquisition

Roles

1 MBIE research on Beveridge curve: http://www.mbie.govt.nz/info-services/employment-skills/labour-market-reports/jobs-online/jobs-online-quarterly-report-march-2018
Source: Stats NZ LEEDS.

1.3. Understanding skill overlaps can improve job matches

With the proliferation of new data sources, there is an opportunity to better support the many decisions around work, training and service design that students, educators, workers, employers and governments make every day.

A cluster analysis that highlights the similarity of skill requirements in a variety of jobs could help to improve matching in highly dynamic labour markets (Exhibit 4). Often, there are substantial overlaps in the core skills that employers demand in various jobs. This means that a range of professions which at first glance appear very distinct – a chef and a mechanic, a farm manager and a lawyer – share surprisingly similar skill profiles. Knowing which occupations and roles share the same core skills can broaden career opportunities and help educators to craft the most relevant curricula and courses to support transitions between related occupations. It can also allow policymakers and employers to fine-tune their employment strategies in New Zealand's changing labour market.

Exhibit 4

Clustering jobs improves the ability to match and transition between jobs by demonstrating skills that are common to many jobs

To respond to the dynamism of careers and complexity of current training pathways, many international jurisdictions have moved to career streams, routes or clusters to group jobs based on similar skills e.g. UK "routes"[1], "career streams" in the US, and Australia's "clusters" produced by the Foundation for Young Australians.

Utility of cluster framework

- A model of the labour market with a strong quantitative basis
- Derived from employer and industry-stated preferences
- A communication tool to simplify job and transition choices

EXAMPLE:

141,000 New Zealanders including:

- *Lawyers*
- *Architects*
- *Teachers*

Holding skills such as: relationship building, creativity, and deep domain expertise

This model identifies common skills between jobs

Skill A

Cluster 1

Cluster 2

Skill X

Skill B

Skill C

Cluster 3

This model enables us to quantify the number of ways people can transition between jobs based on commonly-held skills

Some skills are shared across multiple clusters, underscoring their importance

Some skills are shared across multiple clusters, underscoring their importance

Understanding transitions can help with:
- Addressing skill shortages
- Transitioning older workers
- Transitioning workers in declining occupations
- Roadmaps for young people

Note: 1 For an example of UK "routes", see the UK government's Use of Routes, Report of the Independent Panel on Technical Education April 26 2018

2. METHOD: BIG DATA HIGHLIGHTS COMMON SKILLS BETWEEN OCCUPATIONS

To help with the 1.2 million job matches in the New Zealand economy each year, this report seeks to shed light on the skills that are common in a range of different jobs. If several jobs share a set of skills, then they can be said to form a natural group or cluster. Workers can expect to share similar core qualities and skills across all jobs within one cluster.

To find out how jobs in New Zealand cluster together, we used a database from a company that collects online job advertisements, Burning Glass. This database includes over one million New Zealand job advertisements over four years, from 2014 to 2017 (Exhibit 5). Burning Glass collects over 50,000 unique skills which are coded according to a set of common terms. This empirical reflection of employer demands provides us with a powerful overview of the New Zealand labour market.

The data was standardised so that each advertisement, and the skills listed within it, could be linked to an occupation code. The analysis was conducted at the 4-digit ANZSCO (Australian and New Zealand Standard Classification of Occupations) level.

We applied a *k*-means clustering algorithm to this data set to find cohesive clusters of jobs in New Zealand. These statistical clusters included both groups of different sizes: some with many jobs and others with only a few. Each cluster was characterised firstly, through a qualitatively assessment of the nature of work common across all the member jobs, and secondly, by quantitatively analysing the most popular skills represented within each cluster.

The data set is limited in a number of ways. First, as it is a description of average skills from job advertisements, it does not describe the average worker's skills for that occupation but instead reflects employer demands. This means that the analyses reveal whole-of-economy patterns and would not serve as advice for an individual worker and their unique skill set and job preferences. Skills data for uncommon jobs is also sparse, meaning that 41 out of a total of 350 occupation codes were represented by fewer than 100 advertisements. Occupation codes with insufficient data were filtered out.

The data set has roughly the same proportion of online job advertisements as the proportion of employment at the 1-digit occupation level in the community workers, administrative workers, sales workers, machinery operators and drivers, and labourers. A comparison of the advertised occupations with national employment data found that most of the missing data from non-advertised jobs are managerial positions. According to New Zealand's Household Labour Force Survey, 20 per cent of New Zealanders are employed in managerial positions, but just 12 per cent of advertisements in our data set relate to these occupations. The data set is slightly overweight in professional workers. Analysis of US online job advertisements versus employment has demonstrated a relationship between online job ads and new hires. However, online job ads don't capture employers who still use more traditional means of advertising, such as newspapers, career fairs, word of mouth or employees' social networks. Academic papers have estimated that between 60 and 70 percent of job openings are posted online.* The data set also does not include jobs which are not advertised, meaning that informal hires are not captured

* Georgetown University Center on Education and the Workforce (April 2014) "Understanding online job ads data: A technical report"

Our methodology uses big data to understand the job clusters of the NZ labour market

Collect data
- We used Burning Glass' proprietary database of over **1M NZ job ads** over 4 years (2014-2017)
- For each occupation, we collated the technical and generic skills demanded by the job ads
- We excluded occupations represented by fewer than 100 job ads

Statistical clustering
- We performed a clustering analysis on the combined job ad data set
- Each data point is an occupation; points with similar skills cluster together
- The clustering algorithm identifies **groups of occupations that demand similar skills**

Characterising job clusters

547,000 New Zealanders

Cluster
- Plumbers
- Carpenters
- Builders
- Bricklayers

- **Each cluster can be defined by a set of prominent skills**
- We manually assigned occupations which had been filtered out to a cluster
- We assessed current and future size of each cluster based on NZ employment data

Source: Burning Glass Labour Insight, AlphaBeta analysis

3. THE SIX JOB CLUSTERS IN NEW ZEALAND

3.1. Six groups of occupations share similar skill sets

Our analysis found six main job clusters in New Zealand (Exhibit 5): 'Inventors', 'Organisers', 'Operators', 'Healers', 'Engagers', and 'Crafters':

- **'Inventors':** creative professionals with strong technology, business, and problem-solving skills.

- **'Organisers':** workers with service-oriented and administrative skills.

- **'Operators':** workers with strong manual and communication skills, and a positive attitude.

- **'Healers':** workers with caregiving expertise, and some administrative and corporate skills.

- **'Engagers':** workers with deep interpersonal skills needed in retail and hospitality.

- **'Crafters':** workers with sophisticated industrial, technical and organisational skills.

Exhibit 5

The professions and skills that form these clusters permeate traditional industry divisions. This means that one cluster comprises various occupations from different ANZSCO codes. It also means that a workplace can have workers from several different clusters. Take a farm, for example. The

traditional perspective would be to classify the farm business and its workers as part of the agriculture industry.

The cluster perspective breaks with the traditional classification. It considers the farm managers, who oversee the business, as part of the 'Inventors' group of occupations. 'Inventors' solve the many problems and challenges of a farm business by relying on their creativity, leadership and expertise. They work closely with 'Organisers' such as accountants and business support staff. The workers who tend crops and livestock, or harvest and pack produce would be classified as 'Operators', as are the truck drivers who take delivery of the farm's goods. When their machinery fails, they are visited by 'Crafters' such as mechanics, electricians, engineers and other highly skilled technicians.

3.2. 'Inventors' and 'Organisers' are the largest clusters in New Zealand

New Zealand's workforce of 2.5 million is distributed unevenly amongst the six job clusters. About one-quarter of the workforce are 'Inventors' (620,000 workers) and about another quarter are the 'Organisers' (580,000 workers).[22] The dominance of these two clusters reflects the strong information and services base of the NZ economy (Exhibit 6).

Exhibit 6

New Zealand's job clusters range in size, with 'Inventors' as the largest cluster of jobs with similar skills

68 occupations, ~620,000 workers
Solicitors | Scientists | Architects | Policy analysts

57 occupations, ~580,000 workers
Real estate agents | Secretaries and clerks | Event organisers | Accountants

78 occupations, ~560,000 workers
Drivers | Glaziers | Gardeners | Machine operators | Forestry workers

48 occupations, ~430,000 workers
Waiters | Gallery, museum, and tour guides | Telemarketers | Sales assistants

32 occupations, ~170,000 workers
Carpenters and joiners | Mechanics | Aircraft maintenance engineers | Boat builders

26 occupations, ~150,000 workers
Medical professionals | Veterinarians | Social workers | Pharmacists | Occupational therapists | Aged Care Workers

NOTE: Number of workers in each cluster was estimated according to Stat NZ's Household Labour Force Survey (HLFS). Occupations correspond to 4-digit ANZSCO classifications.
SOURCE: Based on a k-means clustering analysis using Burning Glass data from 2014-2017, comprising of over 1 million job ads, matched to employment data from the March 2018 Household Labour Force Survey

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[22] Stats NZ Household Labour Force Survey (HLFS) 2018.

3.3. Each cluster is underpinned by a set of distinct specialised and general skills

<div style="background:teal">

Glossary:

- Specialised skills are often technical in nature, relating to profession-specific tasks. Carpentry, surgery, and business analysis are examples of specialised skills.
- General skills include cross-cutting skills like writing, problem solving, communication and detail orientation.

</div>

Some core skills are in high demand across all jobs in New Zealand, regardless of the cluster in which they are most common. For example, our analysis found that **communication is the most universally required skill** across all clusters.[23] A substantial share of employers seek out employees who are good listeners, can express themselves cogently, and understand instructions well.

Other skills are also prominent across all clusters. **Interpersonal and people skills**, such as customer service and building relationships, are in strong demand in four clusters: 'Inventors', 'Organisers', 'Engagers', and 'Healers' (see Exhibit 7). Amongst 'Crafters' and 'Operators', there is less emphasis on interpersonal ability and more on mindset and attitude. Between 5 - 8 per cent of jobs in both clusters demand a **positive disposition**, an **energetic mindset**, and **good time management** (Exhibit 7).

Specialised skills most obviously distinguish one cluster from another. These skills are often technical in nature and typically require some degree of formal training. Most jobs in the 'Inventors', 'Healers', and 'Crafters' cluster require specialised skills. Workers pursuing careers in these three clusters have probably been educated at tertiary institutions like universities or technical colleges. Some of the specialised skills of 'Organisers', 'Operators', and 'Engagers' also require formal study but many of their key skills such as customer service, logistics or sales are commonly acquired on the job.

These skills are most commonly required in occupations within each of the six clusters:

- **'Inventors':** use a mix of management, corporate, and technology skills to perform their roles. Skills in high demand are project management skills (18 per cent of job ads), customer service skills (7 per cent), as well as proficient use of programming languages SQL (6 per cent) and JavaScript (5 per cent). Demand for workers adept with JavaScript is rising as more enterprises move online.

- **'Organisers':** one of the most popular specialised skills of 'Organisers' is customer service (23 per cent). Budgeting (9 per cent), data entry (8 per cent), and administrative support (5 per cent) are other specialised skills jobs in the Organiser cluster have in common, and they are rising in popularity. These skills are more administrative compared to the specialised skills of the 'Inventors', which are much more specific to a domain of expertise.

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[23] Burning Glass data 2014-2017. Share of online job ads is calculated by taking the number of online job ads that request the skill as a proportion of total job ads where at least one skill is requested.

- **'Healers':** jobs in this cluster require specialised skills, but they are more specific to the medical professions and include working with patients (18 per cent), rehabilitation (10 per cent), and social work (9 per cent).

- **'Engagers':** have specialised skills that do not require much formal training but instead rely on on-the-job training: sales (36 per cent), customer service (19 per cent), and store management (7 per cent).

- **'Operators':** Popular specialised skills amongst 'Operators' include forklift operation (10 per cent) and heavy lifting (7 per cent)

- **'Crafters':** commonly need sophisticated technical skills that are industry-specific, such as cooking (29 per cent), repair (13 per cent), painting (11 per cent), and electrical work (9 per cent).

Exhibit 7

The 'Inventors' are characterised by technology and business skills, alongside creativity and problem solving

Inventors — Creative service workers requiring deep domain expertise
Select occupations include: **Solicitors | Scientists | Architects | Construction managers | Farm managers**

- Less in demand
- Similar demand
- More in demand

Specialised skills		Share of job ads[1] requesting skill (2017)	Change in employer demand (2014-17)	General enterprise skills		Share of job ads[1] requesting skill (2017)	Change in employer demand (2014-17)
Corporate skills	Project management	18%	↑	**Interpersonal skills**	Communication skills	39%	↑
	Budgeting	8%	↑		Building relationships	13%	↓
	Stakeholder mgmt	6%	↑		Leadership	7%	→
	Sales	6%	↑	**Analytical skills**	Problem solving	11%	→
	Business development	6%	→		Organisational skills	8%	→
People skills	Customer service	7%	→		Detail-orientated	9%	↑
	Change management	2%			Creativity	7%	↑
Technology skills	Data analysis	2%	↑		Research	6%	→
	SQL	6%	→		Troubleshooting	3%	→
	JavaScript	5%	↑				
	Software development	3%	→				

Callouts: Professional and business skills are increasingly important · Client service mindset is increasingly important · In-demand tech skills remain important · Good inter-personal skills remain in high demand · Higher order skills like creativity are increasingly valued

Note: [1]Share of online job ads is calculated by taking the number of online job ads that request the skill as a proportion of total job ads where at least 1 skill is requested.
Source: Based on a k-means clustering analysis using Burning Glass data from 2014-2017, comprising of over 1 million job ads

The 'Organisers' are characterised by service-oriented and administrative skills

Organisers

Coordinative services requiring iterative and accurate procedural work
Select occupations include: **Real estate agents | Secretaries and clerks | Event organisers | Accountants**

- Less in demand
- Similar demand
- More in demand

Administrative and service skills dominate this cluster

Competency in specialist administrative software is becoming more attractive

Specialised skills		Share of job ads[1] requesting skill (2017)	Change in employer demand (2014-17)
Sales skills	Customer service	23%	▲ More
	Teaching	5%	▲ More
	Sales	5%	▲ More
Administrative and corporate skills	Administrative support	12%	▶ Similar
	Budgeting	9%	▲ More
	Accounting	12%	▲ More
	Data entry	8%	▲ More
	MYOB (software)	2%	▲ More
	Social Media	1%	▲ More

Communication skills and being detail-orientated is highly valued

Skills related to autonomy and independence are less important than efficiency and organisation

General enterprise skills		Share of job ads[1] requesting skill (2017)	Change in employer demand (2014-17)
Analytical skills	Communication skills	44%	▲ More
	Detail-orientated	21%	▲ More
	Organisational skills	17%	▲ More
	Computer literacy	14%	▲ More
	Time management	11%	▲ More
	Writing	8%	▲ More
	Typing	4%	▶ Similar
Temperamental disposition	Energetic	6%	▲ More
	Multi-tasking	8%	▲ More
	Positive disposition	4%	▲ More

Note: [1]Share of online job ads is calculated by taking the number of online job ads that request the skill as a proportion of total job ads where at least 1 skill is requested.
Source: Based on a k-means clustering analysis using Burning Glass data from 2014-2017, comprising of over 1 million job ads

The 'Operators' are characterised by labour-intensive manual skills, combined with a good attitude and communication

Operators

Manual work requiring strength, dexterity, or competency with machinery
Select occupations: **Drivers | Glaziers | Brick layers | Machine operators | Forestry workers | Farm workers**

- Less in demand
- Similar demand
- More in demand

Manual skills remain important

Specialised skills		Share of job ads[1] requesting skill (2017)	Change in employer demand (2014-17)
Manual labour skills	Heavy lifting	7%	▲ More
	Forklift operation	10%	▲ More
	Hoisting equipment	2%	▶ Similar
	Hand tools	2%	▲ More
	Machine operation	3%	▶ Similar
Compliance skills	OH&S	4%	▶ Similar
	Quality assurance and control	1%	▲ More
Administrative and corporate skills	Customer service	6%	▲ More
	Logistics	1%	▲ More
	Record keeping	1%	▶ Similar

Communicating well is crucial

Temperament and disposition are prominent features of this cluster

Organisation and planning are important

General enterprise skills		Share of job ads[1] requesting skill (2017)	Change in employer demand (2014-17)
Communication skills	Communication skills	20%	▲ More
	English	6%	▲ More
	Computer literacy	4%	▼ Less
	Writing	2%	▶ Similar
Temperament and disposition	Positive disposition	7%	▲ More
	Energetic	5%	▶ Similar
	Time management	5%	▲ More
	Multi-tasking	2%	▶ Similar
Analytical skills	Organisational skills	5%	▶ Similar
	Problem solving	3%	▲ More
	Physical demand	2%	▲ More

Note: [1]Share of online job ads is calculated by taking the number of online job ads that request the skill as a proportion of total job ads where at least 1 skill is requested.
Source: Based on a k-means clustering analysis using Burning Glass data from 2014-2017, comprising of over 1 million job ads

The 'Healers' are characterised by caregiving expertise and intermediate corporate skills

Healers

Wellbeing services requiring sensitive personal skills
Select occupations: **Medical professionals | Veterinarians | Social workers | Pharmacists | Occupational therapists | Aged Care Workers**

- Less in demand
- Similar demand
- More in demand

Patient care and management are in-demand

Administrative and routine, manual skills are becoming less important

Interpersonal demands are a large share of demanded skills

Caregiving and management skills / Administrative and corporate skills	Specialised skills	Share of job ads[1] requesting skill (2017)	Change in employer demand (2014-17)
Caregiving and management skills	Working with patients	18%	More in demand
	Rehabilitation	10%	Less in demand
	Social work	9%	More in demand
	Clinical leadership	4%	Similar demand
	Nurse management	4%	Similar demand
Administrative and corporate skills	Budgeting	2%	Similar demand
	Case management	4%	Similar demand
	Staff management	1%	Similar demand
	Service improvement	1%	Less in demand
	Data entry	1%	Less in demand

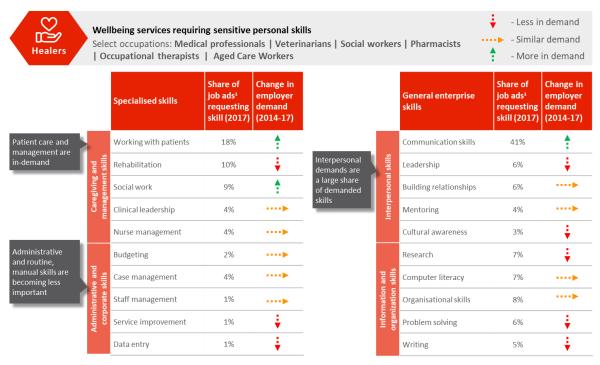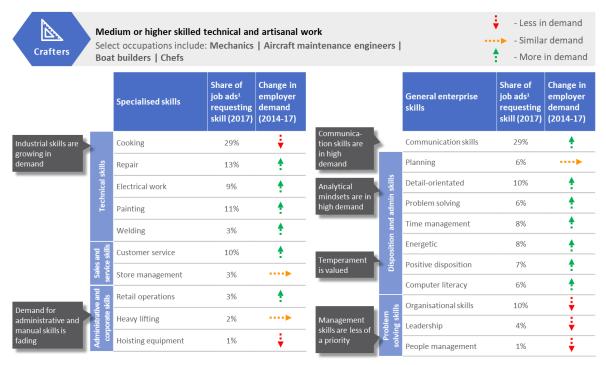| Interpersonal skills / Information and organization skills	General enterprise skills	Share of job ads[1] requesting skill (2017)	Change in employer demand (2014-17)
Interpersonal skills	Communication skills	41%	More in demand
	Leadership	6%	Less in demand
	Building relationships	6%	Similar demand
	Mentoring	4%	Similar demand
	Cultural awareness	3%	Less in demand
Information and organization skills	Research	7%	Less in demand
	Computer literacy	7%	Similar demand
	Organisational skills	8%	Similar demand
	Problem solving	6%	Less in demand
	Writing	5%	Less in demand

Note: [1]Share of online job ads is calculated by taking the number of online job ads that request the skill as a proportion of total job ads where at least 1 skill is requested.
Source: Based on a k-means clustering analysis using Burning Glass data from 2014-2017, comprising of over 1 million job ads

The 'Engagers' cluster is characterised by retail and hospitality capabilities, combined with strong interpersonal skills and positive attitude

Engagers

Services requiring outstanding interpersonal skills
Select occupations include: **Waiters | Gallery, museum, and tour guides | Telemarketers | Sales assistants**

- Less in demand
- Similar demand
- More in demand

Sales skills are important compared to administrative skills

Interpersonal skills compose a high share of demanded skills

Temperament and organiza-tion is in high demand

Sales skills / Administrative and corporate skills	Specialised skills	Share of job ads[1] requesting skill (2017)	Change in employer demand (2014-17)
Sales skills	Sales	36%	More in demand
	Customer service	19%	More in demand
	Account management	3%	Similar demand
Administrative and corporate skills	Store management	7%	Similar demand
	Merchandising	8%	More in demand
	Product knowledge	4%	Similar demand
	Budgeting	5%	More in demand
	Business development	3%	More in demand
	Negotiation skills	2%	Similar demand
	OH&S	1%	Similar demand

Communication skills / Analytical skills / Temperamental disposition	General enterprise skills	Share of job ads[1] requesting skill (2017)	Change in employer demand (2014-17)
Communication skills	Communication skills	32%	More in demand
	English	7%	More in demand
Analytical skills	Organisational skills	10%	More in demand
	Detailed-orientated	10%	More in demand
	Energetic	9%	More in demand
Temperamental disposition	Building relationships	8%	Similar demand
	Computer literacy	8%	More in demand
	Positive disposition	6%	More in demand
	Time management	8%	More in demand
	Multi-tasking	4%	Similar demand

Note: [1]Share of online job ads is calculated by taking the number of online job ads that request the skill as a proportion of total job ads where at least 1 skill is requested.
Source: Based on a k-means clustering analysis using Burning Glass data from 2014-2017, comprising of over 1 million job ads.

The 'Crafters' are characterised by sophisticated industrial skills which require technical training, combined with organizational skills

Crafters

Medium or higher skilled technical and artisanal work
Select occupations include: **Mechanics | Aircraft maintenance engineers | Boat builders | Chefs**

- Less in demand
- Similar demand
- More in demand

	Specialised skills	Share of job ads¹ requesting skill (2017)	Change in employer demand (2014-17)
Technical skills	Cooking	29%	↓ (red, less)
	Repair	13%	↑ (green)
	Electrical work	9%	↑ (green)
	Painting	11%	↑ (green)
	Welding	3%	↑ (green)
Sales and service skills	Customer service	10%	↑ (green)
	Store management	3%	→ (orange)
Administrative and corporate skills	Retail operations	3%	↑ (green)
	Heavy lifting	2%	→ (orange)
	Hoisting equipment	1%	↓ (red)

	General enterprise skills	Share of job ads¹ requesting skill (2017)	Change in employer demand (2014-17)
Disposition and admin skills	Communication skills	29%	↑ (green)
	Planning	6%	→ (orange)
	Detail-orientated	10%	↑ (green)
	Problem solving	6%	↑ (green)
	Time management	8%	↑ (green)
	Energetic	8%	↑ (green)
	Positive disposition	7%	↑ (green)
	Computer literacy	6%	↑ (green)
Problem solving skills	Organisational skills	10%	↓ (red)
	Leadership	4%	↓ (red)
	People management	1%	↓ (red)

Callouts: Industrial skills are growing in demand · Demand for administrative and manual skills is fading · Communication skills are in high demand · Analytical mindsets are in high demand · Temperament is valued · Management skills are less of a priority

Note: ¹Share of online job ads is calculated by taking the number of online job ads that request the skill as a proportion of total job ads where at least 1 skill is requested.
Source: Based on a k-means clustering analysis using Burning Glass data from 2014-2017, comprising of over 1 million job ads

3.4. Growing employer demand for caregiving, information and creativity

We analysed the growth of each cluster in the short to medium term to understand which jobs and skills might increase and which might decline in the future. This trend analysis allows us to recognise opportunities and challenges for the workers who hold these skill sets (Exhibit 8).

Occupations in the '**Healers**' and '**Inventors**' clusters are set to grow fastest, according to employment forecasts.[24] Their growth means that most new jobs will come from these two sources, and this trend is also reflective of the type of economy New Zealand is developing into: one that prizes services in caregiving, information and creativity. These skills are set to become highly sought after.

Wellbeing services, such as nurses, nutritionists, and physiotherapists, provide a wealth of opportunity for current and prospective 'Healers'. Jobs in the 'Healers' cluster are growing at 3 per cent per year, in part due to New Zealand's ageing population and in part due to the changes in medical technologies.[25] High-skilled professional services promise further employment opportunities for

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[24] MBIE (2017), "Employment forecast to grow by 152,000 over the next three years". Available at: www.mbie.govt.nz/about/whats-happening/news/2017/employment-forecast-to-grow-by-152-000-over-the-next-three-years.

[25] Keene et al. (2016) "Funding New Zealand's public healthcare system: time for an honest appraisal and public debate". Available at: https://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2016/vol-129-no-1435-27-may-2016/6891.

people in the 'Inventors' cluster, which is growing at the second-fastest rate (2.7 per cent per year). With the strong growth outlook in both the 'Investors' and 'Healers' cluster, several occupations are set to be in high demand in the future, including chemical and materials engineers, software programmers, web developers (all 'Inventors'), as well as healthcare professionals like physiotherapists and midwives (both 'Healers'). These occupations are growing strongly at 5 per cent per year.

Other clusters are growing less quickly and will generate comparably fewer opportunities. For example, jobs in the highly service-orientated '**Organisers**' cluster are growing at an average of 1.9 per cent per year. 'Organisers' do work that is largely procedural in nature, requiring the same service or task reproduced accurately and proficiently. Additionally, jobs in the '**Crafters**' cluster are growing at an average rate of 1.4 per cent per year. '**Engagers**' (1.3 per cent) and '**Operators**' (1.0 per cent) are the slowest growing clusters, meaning demand for call centre workers ('Engagers'), screen printers, and miners (both 'Operators') will be less buoyant than for other occupations in the New Zealand economy.

Exhibit 8

Educators and students can be mindful of the fastest-growing clusters, namely 'Healers' and 'Inventors'

4. THE POTENTIAL OPPORTUNITIES THAT CLUSTERING ANALYSIS REVEALS FOR NZ

4.1. Skills are portable across many jobs

In an economy where job switches are common and the mix of occupations continues to change, workers benefit from understanding in which roles they can best use their skills. Such knowledge makes switching jobs easier and improves awareness of the type of training a worker may need to make the next career move. While a comprehensive mapping of the shared skills between each occupation is beyond the scope of this report, it is possible to approximate the average portability of skills from one occupation to another.

Skills portability is broadly dependent on three things: a person's current ability to perform the new job well, the amount of training required to close any gaps in competency, and a worker's desire and capacity to make the switch. The first two criteria are closely linked: workers in related occupations should presumably require similar skills. Unrelated occupations are more likely to be separated by large skill gaps which an individual can only overcome with substantial training. Thirdly, the desire to switch may be dependent on various reasons, including a job's financial attractiveness and a worker's personal career aspirations. Meanwhile, the capacity of a worker to make a switch is dependent on a number of contextual factors, be they financial or family-related. With this in mind, portability has been estimated according to three criteria: the amount of skills shared between two jobs, the level of training demanded by the two jobs, and the potential for equal or additional earnings when moving from the first job to the second (Exhibit 9).

The analysis shows that an average individual in New Zealand who is working or training in one job acquires skills for 12 other jobs (Exhibit 10). For example, the average worker in 'Operators' has skills that would enable them to transition into 10 other jobs within the cluster and two roles outside the cluster.[26]

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[26] AlphaBeta analysis on the possible transitions between jobs based on shared skills using Burning Glass data from 2014-2017, comprising over 1 million job ads.

Exhibit 9

Methodology: Portability is measured using a three-step process that assesses skill similarity, education requirements, and earnings similarity
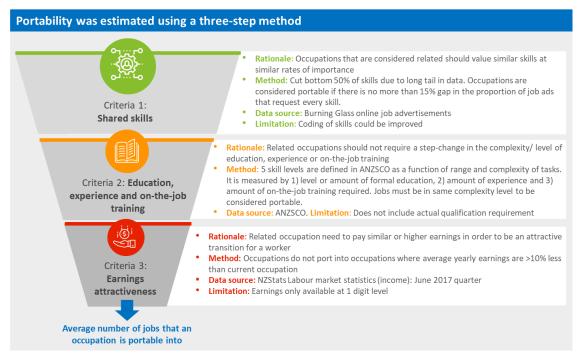
Portability was estimated using a three-step method

Criteria 1: Shared skills

- **Rationale**: Occupations that are considered related should value similar skills at similar rates of importance
- **Method**: Cut bottom 50% of skills due to long tail in data. Occupations are considered portable if there is no more than 15% gap in the proportion of job ads that request every skill.
- **Data source**: Burning Glass online job advertisements
- **Limitation**: Coding of skills could be improved

Criteria 2: Education, experience and on-the-job training

- **Rationale:** Related occupations should not require a step-change in the complexity/ level of education, experience or on-the-job training
- **Method:** 5 skill levels are defined in ANZSCO as a function of range and complexity of tasks. It is measured by 1) level or amount of formal education, 2) amount of experience and 3) amount of on-the-job training required. Jobs must be in same complexity level to be considered portable.
- **Data source:** ANZSCO. **Limitation:** Does not include actual qualification requirement

Criteria 3: Earnings attractiveness

- **Rationale:** Related occupation need to pay similar or higher earnings in order to be an attractive transition for a worker
- **Method:** Occupations do not port into occupations where average yearly earnings are >10% less than current occupation
- **Data source:** NZStats Labour market statistics (income): June 2017 quarter
- **Limitation:** Earnings only available at 1 digit level

Average number of jobs that an occupation is portable into

Exhibit 10

On average, an occupation has valuable skills that are portable, or transferable, to 12 other occupations

Average portability

On average, an occupation has valuable skills that are transferable to

12

other occupations

Portability within and between clusters

Cluster	No. of transferable occupations for the average worker		
	Within cluster	Between clusters	Total
Organisers No. of occupations: 78	4	11	**15**
Inventors No. of occupations: 68	9	6	**15**
Healers No. of occupations: 48	4	9	**13**
Engagers No. of occupations: 57	2	9	**11**
Operators No. of occupations: 26	10	2	**12**
Crafters No. of occupations: 32	4	7	**11**

Source: Portability was measured using shared skills (Burning Glass Labour Insight), similar education and experience level (ANZSCO skill levels), and no decline in earnings (NZ Stats Labour market income (June qtr 2017). Skill shortage information from the NZ Immigration Department, February

4.2. The job clusters framework can help key groups

The job cluster framework unveils new opportunities for students, workers, employers, educators, and government (Exhibit 11).

Exhibit 11

The framework reveals potential opportunities for students, educators, workers, employers, and governments

	Example implications for key groups	Potential implications for governments
Workers	• Understand desirable career opportunities available using current or expanded skill set, including when transitioning from declining occupations • Consider further training / upskilling to access different jobs • Understand opportunities available in specific regions (including relocation opportunities) • Older workers able to identify less physically demanding jobs that use similar skills	• Develop digital interfaces that allow for simple understanding of the job options provided by an individual's current skill set • Map how occupations in decline can transition to other occupations in a region, and provide support for transition • Identify opportunities for older workers to transition to less physically demanding jobs
Employers	• Understand that desired skill sets may be available from other industries and occupations • Openness to teaching skills on-the-job	• Help employers understand how they can access skills in shortage occupations through workers from other occupations
Educators	• Focus on teaching and assessing the top in-demand skills, especially general skills that are unlikely to change • Understand diverse career opportunities for students • Willing to recognize prior learning • Offer top-up qualifications or micro-credentials to enable efficient filling of skill gaps between occupations	• Provide clearer evidence and transparency around recognition of prior learning to enable transitions • Ensure setting of policy goals and incentives to encourage teaching of top skills in-demand within each cluster (including in NCEA and VET reviews) • Consider ways to foster lifelong learning
Government	• Understand how the skill needs of the public sector are changing, • Understand relevant roles from which to source talent from outside the sector • Map employment by clusters in key geographies, for cross-agency regional development activity • Ensure key government occupation-based datasets leverage the cluster classification, where appropriate • Use longitudinal data to understand how current individual pathways and rate of occupation switching	
Students	• Help to build aspiration about diverse job options • Focus on acquiring in-demand skills for desired occupations, especially general skills unlikely to change • Understand how to navigate a path to desired occupations	• Articulate possible career roadmaps for students • Assess whether current strategies in education teach students in-demand skills (including in NCEA)

For workers

Potential use case: Transitioning regional workers in declining occupations

Understanding which skills are portable between various occupations in a cluster can assist with transitioning regional workers away from declining occupations. A comprehensive map of skill portability between individual pairs of occupations could reveal links between occupations for workers to exploit. By understanding the skills they possess and those demanded by jobs in other industries, workers can plan their transition which may include further formal education or discussing the possibility of on-the-job training with a prospective employer.
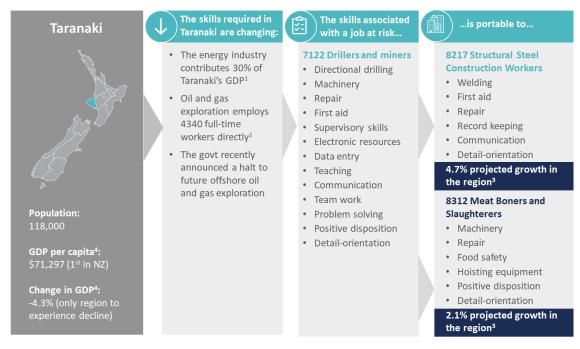
Exhibit 12 and Exhibit 13 examines the region of Taranaki as an example of how portability could be applied to regional workers in transition. With the New Zealand Government's withdrawal from future offshore oil and gas exploration, it is anticipated that the work available in Taranaki will change over the next 30 years[27]. There is an opportunity to consider how workers in and connected to this sector

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[27] Stuff NZ, Taranaki ready to move away from fossil fuel exploration, 20 March 2018
https://www.stuff.co.nz/business/102420256/taranaki-oil-sector-ready-to-move-away-from-fossil-fuel-exploration

could transition, using their transferable skills, into other occupations that are likely to grow in the region. For example, Purchasing and Supply Logistics Clerks in the oil and gas industry share many core skills with HR professionals, and Advertising, PR, and Sales Managers – two occupations that are projected to grow in the region over the next five years.[28]

Exhibit 12

Regional workers in declining jobs: Opportunities for workers in declining regional jobs to transition to jobs in ascent

Taranaki	The skills required in Taranaki are changing:	The skills associated with a job at risk…	…is portable to…
Population: 118,000	• The energy industry contributes 30% of Taranaki's GDP[1]	**7122 Drillers and miners**	**8217 Structural Steel Construction Workers**
	• Oil and gas exploration employs 4340 full-time workers directly[2]	• Directional drilling	• Welding
		• Machinery	• First aid
		• Repair	• Repair
		• First aid	• Record keeping
		• Supervisory skills	• Communication
		• Electronic resources	• Detail-orientation
		• Data entry	**4.7% projected growth in the region[3]**
	• The govt recently announced a halt to future offshore oil and gas exploration	• Teaching	**8312 Meat Boners and Slaughterers**
		• Communication	• Machinery
GDP per capita[4]: $71,297 (1st in NZ)		• Team work	• Repair
		• Problem solving	• Food safety
Change in GDP[4]: -4.3% (only region to experience decline)		• Positive disposition	• Hoisting equipment
		• Detail-orientation	• Positive disposition
			• Detail-orientation
			2.1% projected growth in the region[3]

Source: [1]Venture Taranki Report https://venture.taranaki.info/System/ISSUU-Embed.aspx?cid=19146623/60384608, [2]https://www.stuff.co.nz/business/102420256/taranaki-oil-sector-ready-to-move-away-from-fossil-fuel-exploration , [3]MBIE estimates, 2017-2020, [4]Stats NZ, 2016

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[28] Portability between jobs was estimated using a three-step process, removing the bottom 50 per cent of skills, requiring at least one-third of shared skills, and a similar intensity or proportion of job ads that demand the same skills.
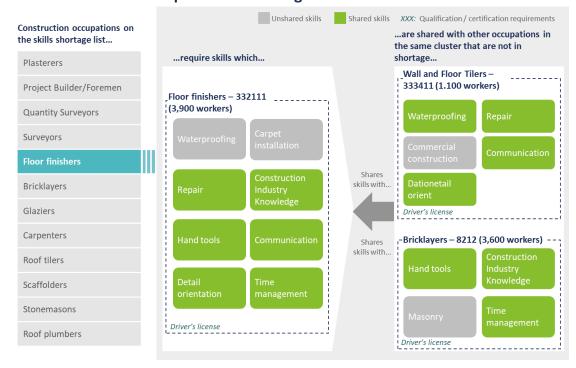
Exhibit 13

Regional workers in declining jobs: Opportunities for workers in declining regional jobs to transition to jobs in ascent

Taranaki

Population:
118,000

GDP per capita[4]:
$71,297 (1st in NZ)

Change in GDP[4]:
-4.3% (only region to experience decline)

The skills required in Taranaki are changing:

- The energy industry contributes 30% of Taranaki's GDP[1]
- Oil and gas exploration employs 4340 full-time workers directly[2]
- The govt recently announced a halt to future offshore oil and gas exploration

The skills associated with a job at risk...

5911 Purchasing and Supply Logistic Clerk
- Microsoft Excel
- Building Relationships
- Purchasing
- Forklift Operation
- Inventory Control
- Warehouse Management
- Customer Service
- Business Management
- Communication & Organisation
- Detail-orientation

...is portable to...

2231 Human Resource Professionals
- Microsoft Excel
- Building Relationships
- Recruiting
- Business Management
- Communication
- Detail-orientation

1.4% projected growth in the region[3]

1311 Advertising, Public Relations, & Sales Manager
- Microsoft Excel
- Building Relationships
- Customer Service
- Business Management
- Organisational Skills

4.4% projected growth in the region[3]

Potential use case: Transitioning workers into physically less demanding roles

Understanding which occupations share similar skills could assist with transitioning workers who have the desire or need to move into physically less demanding roles. For example in Exhibit 14, Delivery Drivers, working in an occupation that requires heavy lifting, could use several of their core skills in physically less demanding occupations such as Transport and Dispatch Clerks and Retail Supervisors. Government could support these transitions by reducing barriers to training to bridge skill gaps for a transitioning worker or by setting in place a credentials system that recognises the skills a worker possesses.

Exhibit 14

Some workers need relief from physical labour: **Some physically-demanding jobs share skills with less demanding jobs**

Some workers need to transition away from occupations that are physically demanding

Physically demanding occupations include: Freight & furniture handlers | Delivery drivers | Packers

Unshared skills   Shared skills   *XXX:* Qualification / certification requirements

Less physically demanding occupations …

Transport & Dispatch Clerks – 5912 (9,000 workers)

Microsoft Excel	Data entry
Invoicing	Communication
Computer Skills	

Secondary education

Retail Supervisors – 6215 (5,500 workers)

| Merchandising | Budgeting |
| Customer Service | Time Management |

Industry specific training

Shares skills with…

Shares skills with…

… share skills with more physically demanding occupations, from which an older worker can transition

Delivery drivers – 7321 (7,100 workers)

Delivery Driving	Customer Service
Heavy lifting	Transport Logistics
Invoicing	Merchandising
Communication	Time Management

Driver's license

Potential use case: Workers choosing new roles and pathways

Understanding the jobs that are related in a cluster, and potentially beyond a cluster, provides examples and options of promising pathways for an individual worker who might want to switch jobs. For example, a worker can understand the different, and perhaps surprising, jobs that share similar skills to their current job and the different opportunities they could pursue. If qualifications are also matched to occupations or clusters, then individual workers might also be able to understand what upskilling or training they would require in order to access a new suite of roles.

For employers

Potential use case: addressing skill shortages

Understanding how occupations cluster together based on shared skills can help employers to overcome talent shortages. Key clusters with skills shortages include the 'Inventors' (with 20 occupations listed on the Department of Immigration's skill shortage list), 'Operators' (with 14 occupations on the skill shortage list) and 'Crafter' (with 11 occupations on the skill shortage list), as seen in Exhibit 15.[29] A comprehensive map of skill portability between individual pairs of occupations

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[29] Immigration NZ Skills Shortage List 2018.

(beyond the scope of this report) can reveal unexpected sources of talent for occupations experiencing a shortage of workers.

How could employers use data on portable skills to alleviate talent shortages? Exhibit 16 provides examples of occupations in the construction industry where companies are struggling to fill vacancies. Exhibit 16 shows how employers could resort to other occupations with similar skill profiles in the same cluster to overcome the talent shortage. For example, a Floor Finisher shares many of the skills of a Tiler, as well as a Bricklayer. While workers would certainly need to acquire specific skills related to plastering and painting, the analysis shows that there are more suitable candidates for a vacant role than employers may think.[30]

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[30] Portability between jobs was estimated using a three-step process, removing the bottom 50 per cent of skills, requiring at least one-third of shared skills, and a similar intensity or proportion of job ads that demand the same skills.

Exhibit 15

Skills shortages: Understanding portability allows employers and government to identify who could fill skills shortages

Skill shortage jobs within clusters
Number of jobs on the Department of Immigration's skills shortage list by cluster

Cluster	Number
Inventors	20
Operators	14
Crafters	11
Engagers	5
Healers	5
Organisers	3

Sample of jobs on the skills shortage list
- ICT Professional
- Medical technicians
- Floor finishers
- Scaffolder

Jobs that are qualification agnostic can source talent from related occupations to train on the job

Jobs that require specific qualifications can source talent from occupations with similar skill sets with additional training

Potential occupations within cluster suitable to fill the skills shortage gap
- Software engineers
- ICT Systems Test Engineer
- Developer programmers
- Agricultural technician
- Pathology collector
- Wall and floor tilers
- Bricklayers
- Steel fixer
- Fencer

- The Inventors, Operators, and Crafters clusters contain jobs with the highest need for workers
- Potential workers can be sourced and trained from the same cluster as they already have some of the requisite skills

Source: Based on a k-means clustering analysis using Burning Glass data from 2014-2017, comprising of over 1 million job ads, matched to employment data from the March 2018 Household Labour Force Survey. Skill shortage information from the NZ Immigration Department, February

Exhibit 16

Skills shortages: Some 'Construction' occupations that are not in shortage share skills with occupations in shortage

Construction occupations on the skills shortage list…
- Plasterers
- Project Builder/Foremen
- Quantity Surveyors
- Surveyors
- Floor finishers
- Bricklayers
- Glaziers
- Carpenters
- Roof tilers
- Scaffolders
- Stonemasons
- Roof plumbers

Unshared skills | Shared skills | XXX: Qualification / certification requirements

…require skills which…

Floor finishers – 332111 (3,900 workers)
- Waterproofing
- Carpet installation
- Repair
- Construction Industry Knowledge
- Hand tools
- Communication
- Detail orientation
- Time management
- Driver's license

…are shared with other occupations in the same cluster that are not in shortage…

Wall and Floor Tilers – 333411 (1.100 workers)
- Waterproofing
- Repair
- Commercial construction
- Communication
- Dationetail orient
- Driver's license

Shares skills with…

Bricklayers – 8212 (3,600 workers)
- Hand tools
- Construction Industry Knowledge
- Masonry
- Time management
- Driver's license

Shares skills with…

Source: Portability was measured using shared skills (Burning Glass Labour Insight), similar education and experience level (ANZSCO skill levels), and no decline in earnings (NZ Stats Labour market income (June qtr 2017). Skill shortage information from the NZ Immigration Department, February

Potential use case: understanding top skills in demand for curriculum development

Educators could use information about the top skills demanded by employers in various job clusters to ensure their curriculum remains relevant to employer demands. A university, for example, could ensure that the most common core skills required by employers in the 'Inventors' and 'Healers' job clusters – the fastest growing clusters – are embedded in their curricula and extend into their conception of an ideal graduate. They may also decide to identify a subset of their degree programmes as belonging to a cluster so that they can teach the skills important to that cluster across that subset of degrees. Such an approach would enhance their graduates' mobility between occupations in their cluster as they would possess a common, useful skill base.

High schools could turn their attention to ensuring their students master fundamental core skills required across all clusters, such as communication and organisational skills, time management, and computer literacy. The clusters framework could also be used to provide career advice to students. Educators can direct them to the skills they need to cultivate to enter their desired cluster. Schools can also review their extracurricular activities to see if they are providing their students the opportunities to cultivate such skills.

Potential use case: recognition of prior learning and top-up qualifications

Understanding which skills are portable between occupation clusters can help workers make better career and education choices. However, an effective job matching based on skill portability requires transparency. There should be clear rules for the recognition of a worker's learning outcome and experience from previous jobs. For example, the government could develop skills lists for each occupation by tracking (with the help of big data tools) which skills workers typically acquire when studying or working in a particular field of expertise.

These lists could form the basis of a more automated and transparent system which recognises prior learning and experience. Such a system could use longitudinal data sets to identify common skills associated with popular occupational pathways. The system could support worker transitions, as it would highlight where a worker may need to add new qualifications in order to meet skill requirements in a desired occupation. For the system to work, educators would need to find effective means to acknowledge prior learning, such as offering micro-credentials, which would enable workers to efficiently fill small skill gaps.

Potential use case: Mapping vocational pathways

In senior secondary school, learners can align their learning to six Vocational Pathways (VPs). These pathways are grouped by broad industry type, namely: Primary Industries, Services Industries, Social & Community Services, Manufacturing & Technology, Construction & Infrastructure, and Creative Industries. The Vocational Pathways serve several purposes:

- They provide a basis for teachers to design course curricula and NCEA assessment, by identifying learning and assessment standards which are likely to be of coherence and lead to similar industry pathways.

- They offer an opportunity for learners to signal, and employers to understand, the ways in which learners have specialised their NCEA. This is particularly acute at NCEA Level 2, where

a Vocational Pathways award is available to learners who achieve 60 credits from recommended assessment standards aligned to a Vocational Pathway (including 20 sector-related standards – which are more closely connected to workplace experiences in the industry).

- They provide a framework for students to show how their learning and achievement is valued in the workplace by aligning learning to the skills needed for industry.

Making good decisions in designing pathways is challenging for both learners and teachers – in part due to the breadth of curriculum and assessment opportunities, and because of the proliferation of vocational education and training (VET) qualifications. The clusters analysis provides an opportunity to assess the relevance of the Vocational Pathways by testing the extent to which the six Pathways align to relevant skill clusters in the economy.

Given the link between the curriculum, standards and Vocational Pathways awards, future research may involve evaluation of the degree of fit between pathways and skills clusters. This could allow strengthening of the Pathways to make them a more useful curriculum design tool and signal of learners' capabilities by ensuring that learners can maintaining a diversity of pathways into further education and employment. It is therefore timely to take the opportunity to see how Vocational Pathways and Skills Clusters may be part of a connected tool or resource to support learners, whānau, educators and employers to create easier, stronger transitions between secondary education, tertiary education and the world of work.

Some countries, including Australia, have begun to link qualifications to clusters, rather than individual occupations, in an attempt to support young workers in their career planning. In New Zealand, a similar cluster approach could help guide young people more effectively through the current mass of 1,200 VET-level qualifications to their desired pathway into learning and work.[31] Countries elsewhere in the world have implemented similar approaches by creating 'routes' or 'streams' of work which represent multiple occupations. This makes decisions on future pathways more relevant for young people and more connected to their current and future education and training. From an educator's point of view, grouping students by clusters, routes, or streams instead of individual occupations may be a better basis upon which to teach core foundational skills which are useful across multiple occupations.

Potential use case: alignment with NCEA

There is an opportunity to ensure that the most common cross-cutting skills required by employers are embedded in New Zealand's National Certificate of Educational Achievement (NCEA). The current review of NCEA provides an opportunity to ensure that NCEA encourages, through the appropriate design of credentials and incentives, the development of skills which are cross-cutting and useful for a range of pathways. These insights could also feed into future National Curriculum development, or into the design of local curriculum for schools.

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[31] NZQA Targeted Review of Qualifications 2017 www.nzqa.govt.nz/qualifications-standards/quals-development/targeted-review-of-qualifications

Potential use case: building career understanding, aspirations and roadmaps for young people

The job cluster framework can help young people realise their career aspirations by improving their decision making on what to study and where to study. Exhibit 17 outlines a potential pathway that a young person could follow. For example, a digital tool – based on the analysis – could help a young person find out which job cluster most closely matches his or her individual interests and skills, and how to gain work experience in an entry-level job in that cluster. It could also help that young person find a course that builds the necessary skills and show them how to transition to an entry-level role in a cluster before transitioning to a more experienced role. Such assistance offers tangible and concrete recommendations instead of the often vague and generic advice that young people receive. The tool could also help to foster aspiration by helping young people to identify career goals, and signal to them that a career is an ongoing learning journey with many changes in jobs and occupations.

Combined with a range of other government and community support programs, the tool can be used by social sector agencies as a resource to help young people not engaged in education, training, or employment. Such a tool would identify a young person's interests, the skills they already possess from prior employment or study, and (where possible) entry-level employment opportunities in their region.

To help simplify complex decisions around the many training options available to a young person in New Zealand (for example, the 1,200 vocational level qualifications), qualifications could be mapped to either occupations or occupational clusters.

Exhibit 17

Roadmap for young person: a young person can make a broader set of work & study choices

Young person can consider cluster that best fits skills, interests, and aspirations
E.g. "I like helping people and have good organizational & teamwork skills. I aspire to work in healthcare or education."

Gain work experience or paid employment in entry-level job in cluster
E.g. Pharmacy Assistant

Study for higher skilled role in healthcare
E.g. Medical technician

Find course that builds core skills in cluster
E.g. Certificate in education support

Transition to more skilled or experienced role in cluster
E.g. Special education assistant

Transition to entry-level role in cluster
E.g. Personal care worker

Study for higher skilled role in education
E.g. Special education teacher

Source: AlphaBeta analysis

Potential use case: Linking cluster classification to occupation-based data sets

In order to ensure utility of the model within government data sets, existing occupation-based data sets could be linked to the cluster classification. Longitudinal data can be used to understand how individuals currently move between occupations, in order to understand the size of the matching opportunity and which sectors / demographics / populations are currently making transitions with high skill overlaps and which groups require additional guidance or support.

Potential use case: Understanding changing skill needs in government and sourcing talent from other sectors

Government could also use the cluster in their role as an employer. Using the cluster model will enable it to understand changing skills needs of its workforce, the skills that matter most to build in the sub-clusters that government operates in, and the ways to source new or different talent from occupations with similar skills, outside of the public sector.

CONCLUSION

Finding a job that suits an individual's skills not only benefits workers, but also their families, whānau, communities, and the whole nation. It is therefore crucial for New Zealand's labour market to have a strong capacity to efficiently match workers with jobs. It can encourage the prosperity of local businesses who require talent to thrive, improve the health of regional communities, and opening new opportunities for workers who desire a career change due to changing circumstances.

The job cluster analysis reveals that jobs within six broad clusters are highly related. Workers who work or train in one job typically acquire core skills they could use to perform 12 other occupations.

These findings suggest that many workers have the capacity to better adapt to dynamic work environments, where jobs and the skills they require are shifting. This may not be apparent to workers who think of their skills as being tied to their current job and industry. Workers who are mobile – and who realise that they are mobile – can not only pursue new opportunities upon their own initiative, but can better transition from an occupation or industry in decline into areas experiencing growth. For employers, this shows that the talent pool from which they can recruit is probably larger than they expect. This is good news for businesses, especially for niche organisations who have unique labour demands.

Custodians of the education and careers system have an important role to play to promote skills that are valued and portable. To help students and workers, educators can modify where and how they teach. As demand for training and retraining will likely grow in the future, educators also need to be flexible and accessible in how they teach, and they need support to do so. Government can facilitate a conducive learning environment by providing financial assistance to workers in need of retraining, or by allowing workers to clearly signal their skills to employers through new credential systems. Designing and implementing new features in the careers system is certainly a challenge. However, if these steps lead to success, New Zealand's workforce will likely be more resilient to potential future shocks in the labour market and feel emboldened to embrace new opportunities throughout their working lives.

APPENDIX A – DETAILED METHODOLOGY

Occupation and skills data set

In collaboration with Burning Glass Technologies, we obtained a data set which describes the skills associated for unique occupations in New Zealand. The data was collected by scraping online job advertisements and collating the skills requested by employers. Skills were categorised as being either general skills or technical skills.

Time period: Our data set is based on online job advertisements posted for New Zealand roles between 1/1/2014 and 31/12/2017.

Occupation classification: Each job advertisement was assigned as a representative of one of 350 occupations as per the latest 4-digit ANZSCO classification. We used the latest definitions of the ANZSCO classification which was last updated in 2013. Occupations that were represented by fewer than 100 advertisements were filtered out from our data set, leaving 309 unique occupations.

Skill intensity: To understand the relative importance of each skill mentioned in relation to an occupation on a job advertisement, we calculated an intensity score. The intensity of a skill corresponds to the number of job advertisements which mention the skill divided by the total number of job advertisements. Each occupation has then a list of skills associated with it, and each of those skills has an intensity score specific for that occupation. Skills which are not mentioned in any advertisement for an occupation receive an intensity score of zero.

Intensity = total mentions of a skill by job ads in occupation / total job ads in occupation

Estimating the structure of job clusters based on shared skills

To estimate the number and structure of job clusters in New Zealand, we first had to calculate relationships between each occupation based on the intensities of their skills. Doing so required comparing occupations in a pair-wise manner and in a way that quantified the differences between a pair of occupations.

Dissimilarity matrix: We calculated a dissimilarity score between each pair of occupations by comparing the intensity scores of each of their skills. We took the squared difference between.

Dissimilarity score = (Intensity of Job A – Intensity of Job B)^2

We repeated this process for all 47,740 possible pairs of occupations to produce a dissimilarity matrix.

Clustering: We applied the PAM (partitioning around medoids) *k*-means clustering algorithm, as implemented in the programming language R, to the dissimilarity matrix. The algorithm proceeds in two steps. First, it selects a set of data points to act as medoids of clusters. Every other data point is then assigned to the cluster belonging to the least dissimilar medoid. Second, the algorithm swaps a medoid with another data point, in the hope of improving the quality of the clusters. The clusters are finalised when the algorithm manages to minimise the average dissimilarity of each data point to its selected medoid. In this case, each data point represents an occupation.

The PAM clustering algorithm requires the number of clusters to be specified before it can categorise the data points. We specified 15 clusters. These clusters were robust to different settings of our

clustering analysis. They were selected under a 20 and 25-cluster analysis, in addition to the 15-cluster analysis.

Our results included nine clusters containing only nine or fewer. These small clusters were manually merged into the other six larger clusters (ranging from 22 to 77 occupations). The resulting six clusters were then characterised manually by inspecting the type of work the set of occupations within a cluster engages in. We also identified and noted the top skills within each cluster according to their intensity (defined above).

Estimating employment within each cluster

Assessing current employment: We estimated the number of workers within each cluster according to data from Stat NZ's Household Labour Force Survey data, published in March 2018. The survey details employment according to ANZSCO occupation classifications, which we aggregated according to the cluster that each occupation belongs to.

Forecasting future employment: We estimated future employment of the clusters according to occupation-specific forecasts from the New Zealand Ministry of Business, Industry, and Employment. These forecasts cover the period between 2018 and 2020. We calculated the compound annual growth rate from these forecasts and extended our estimate of future employment to 2023.

Assessing portability between clusters and occupations

We estimated the average portability of a worker in a given occupation to other occupations. Our analysis here rests on some assumptions. We assume that skills from job advertisement data are a fair reflection of the skills required to perform the tasks an occupation in question demands. We also assume that the average worker in that occupation has a skill set which roughly corresponds to the average of skills represented by the job advertisement.

We set three criteria for determining whether a worker in an occupation is portable to another occupation. Based on these three criteria, we calculated the average portability of the average occupation, which equates to the number of occupations the average worker can move to.

Skill similarity: First, for one occupation to be portable to another, the skills required in the second occupation must be like those in the first. To assess skill similarity, we first removed from consideration the least intense 50 per cent of skills from both occupations. This is to remove spurious skills associated with an occupation from noise in the job advertisement data. Examples of such skills include a specific language or familiarity with a niche industry, which only a handful of advertisements demanded.

Education level: Second, we considered the difference in level of education between two jobs. A pair of occupations may demand very similar skills but the level of intellectual rigour demanded by them may well be very different. We approximated the skill level of each occupation according to Stat NZ's classification which comprises of five levels:

- The first skill level is equivalent to a bachelor's degree or higher. In some instances, five years of relevant work experience is also equivalent.
- The second skill level is equivalent to a New Zealand Register diploma or three years of relevant work experience.

- The third skill level is equivalent to a New Zealand Register Level 4 qualification or at least three years of relevant work experience.
- The fourth skill level is equivalent to a Level 2 or 3 qualification or a year of relevant work experience.
- The fifth skill level is equivalent to a Level 1 qualification or a short period of on-the-job training.

We specified that for one occupation to be portable to another, the target occupation cannot require a higher level of skill than a worker's current occupation.

Remuneration: Finally, we considered differences in remuneration. People change jobs for many reasons, one of which is to better their income. We assume that most workers would not move into a job which pays a lot less than their current job. Our third criterion stipulated that a worker is not portable from their current occupation to one that is 10 per cent lower in income or less. We derived our estimated hourly earnings for ANZSCO occupations using average hourly earnings data from Stats NZ.

Portability within and between clusters: We also estimated portability within and between clusters. Moving within clusters is to move between occupations which share very similar skills whilst moving between them is to undertake a more significant change. For each occupation, we assessed the number of possible switches to other occupations. As each occupation is associated with a cluster, each of these switches were categorised as either within the same cluster or to another cluster. These counts were aggregated and averaged for each cluster.