APEC Closing the Digital Skills Gap Report:

Trends and Insights

Perspectives on the supply and demand of digital skills and degree of digitalization

APEC Human Resources Development Working Group

December 2020

Asia-Pacific Economic Cooperation

burningglass TECHNOLOGIES

LinkedIn

FOREWORD

The coronavirus pandemic has disrupted labor markets like never before. It has amplified the digital skills gap and created more urgent reasons for all stakeholders including governments, employers, academia to invest in digital upskilling and reskilling of the workforce.

According to APEC's Policy Support Unit, unemployment in APEC economies is expected to increase from 3.8 percent in 2019 to 5.4 percent in 2020, which translates to about 81 million people who are jobless this year (23 million more than last year) — this is if we count upon an optimistic scenario wherein we start seeing a recovery right about now.

APEC Trade Ministers acknowledged this impact of COVID-19 on the digital economy in their statement in May 2020 pledging to "harness the opportunities of the digital economy and technologies, through utilisation of smart working solutions that enable seamless international business and cross border trade." This includes strengthening APEC's digital agenda with fresh perspectives and innovative means to navigate these new realities together.

APEC is committed to working with all of its 21 economies to closing the digital skills gap and to boost workforce development in this significant time. Solutions must include not only government, but also partnership from employers and academia – we invite you to join us.

DR. REBECCA STA MARIA
APEC EXECUTIVE DIRECTOR

LETTER FROM THE APEC CLOSING THE DIGITAL SKILLSGAP FORUM CO-CHAIRS

Dear Colleagues,

Companies across the APEC economies are adapting their business models and talent needs in response to the exponential growth in automation and artificial intelligence (AI). Though the state of digitalization varies by each economy - and industry sector within each economy – even the least digital occupations often now require some level of digital skills.

As each APEC economy was navigating its growing digitalization, the COVID-19 pandemic required dramatic changes, with many workers temporarily or permanently separated from employment, and many more transitioning to working remotely. Companies and individuals needed to rapidly find new ways to work and communicate, further necessitating the acquisition and deployment of digital skills. Digital skills and remote work have become critical to retaining employment and to economic survival, with occupations requiring higher levels of digital skills more likely to offer remote work opportunities during these challenging times.

The APEC Closing the Digital Skills Gap Initiative, overseen by the U.S. Department of Labor and co-chaired by Wiley and Business Higher Education Forum (BHEF), has brought together over 400 stakeholders from 18 Asia Pacific economies since 2017 to collaboratively work towards closing the digital skills gap. We are grateful to Burning Glass Technologies and LinkedIn for their research in digital skill demand and supply, identification of gaps, and use of metrics to measure digital intensity across APEC economies. We also appreciate their analyses that shed light on COVID-19 impacts on workers and economies.

The APEC Roadmap to Closing the Digital Skills Gap by 2030 endorsed by the Human Resources Development Working Group in September 2019, lays out a common definition of digital skills, sets aspirational targets, and details APEC-wide actions on a multi stakeholder basis (governments, employers, and academia) to closing the digital skills gap and achieve lifelong employability. This report contributes to these goals by providing data to help APEC economies better understand the digital skills gap along with the APEC Digital Readiness Checklist, designed to help APEC governments, employers, and academia understand their levels of preparedness for jobs in the digital age and to support efforts to upskill and reskill workers amidst COVID-19.

Work and life as we know it have changed. The COVID-19 pandemic may increase the rate of digitalization, and we risk growing economic inequality and occupational mobility if we don't respond. We must come together to better prepare the current and next generation of workers to have the digital skills necessary to succeed in the digital economy. It is key to our continued success and to spreading opportunity across APEC economies.

ANDREW TEIN

VICE-PRESIDENT OF GLOBAL GOVERNMENT AFFAIRS

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EXECUTIVE SUMMARY

With growing digitalization in mind, and building off of APEC Project DARE (Data Analytics Raising Employment), the APEC Closing the Digital Skills Gap Forum commissioned this report to provide insights on the supply and demand of digital skills and degree of digitalization in the APEC economies. Burning Glass Technologies and LinkedIn provided the research and analysis.

Digitalization, the process of employing digital technologies and information to transform business operations, is a prevailing force in all economies studied in this report. Some economies, such as Singapore and Canada experience very high rates of digitalization, while others, such as New Zealand, experienced slower rates of digitalization. However, the trend of digitalization and the creative destruction that comes along with it has taken place to some extent in each economy examined and is likely to increase due to the COVID-19 pandemic. In all economies, it is important for workers to possess digital skills to increase opportunities for finding gainful employment, now and in the future.

For this report, LinkedIn examined digital skill hiring trends by sector and relative digital skill penetration rates of LinkedIn members, differences between digital skills in High-Growth Firms – defined as those with at least 20 percent growth in headcount over the last three years – and other firms, and gaps between digital skill supply and demand. LinkedIn explored 10 economies: the United States, Singapore, Philippines, New Zealand, Mexico, Malaysia, Indonesia, China, Canada, and Australia, and grouped digital skills into four categories: 1) basic digital literacy such as accessing email and using basic applications such as spreadsheets; 2) applied such as technical support, animation, and social media; 3) software and hardware including development, computing and networking; and 4) disruptive tech, which include artificial intelligence, cybersecurity, robotics and developing new tools.

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Burning Glass analyzed the economies of the United States, Australia, New Zealand, Singapore and Canada and categorized digital skills into baseline and six specialized areas. Baseline digital skills are readily transferrable, with a definition that is comparable to LinkedIn's basic skills categories. Specialized skills are grouped into customer relationship management, digital design and marketing, machining and manufacturing data analysis, computer and networking support, and software and programming.

Burning Glass also classified the ratio of job postings in each economy as low, middle, and high skill based on the amount of preparation required, which provides helpful context within and across the APEC economies. Their analysis shows that as the skill level of the job posting increased in each economy, so did the likelihood that the

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LINKEDIN FINDINGS INCLUDED:

- **In developing economies such as China, Indonesia and Mexico, the demand for digitally skilled workers has been growing much faster than supply.**
- **Among LinkedIn members, the rate of hiring individuals with digital talent was fastest (looking at month-on-month change) in New Zealand, Singapore and the United States, and**
- **The demand for different types of digital skills varies by industry and economy, suggesting that different sectors are going through different phases of digital transformation in each economy.**

job posting was for a digital occupation. Additionally, they looked at changes in digital index between 2013 and 2019. This metric calculates the state of digitalization using two components: digital skills required by employers and the cost to achieve those skills. They found all economies to follow a similar pattern except for New Zealand, which showed minimal or negative change between 2013 and 2019 and suggested a unique presence of factors in New Zealand's economy or industry composition.

BURNING GLASS FINDINGS INCLUDED:

- **Baseline digital skills are in high demand and highly transferrable,**
- **Seven out of ten job postings in the economies studied are in digital occupations,**
- **Digitalization and remote work are often interrelated, and**
- **Occupations that are more digital are likely to pay higher wages than other occupations.**

The data in this report will provide APEC economies with information to help them better understand their digital skill landscapes and will support their efforts to craft responsive economic and employment policies and strategies

METHODOLOGICAL NOTES

The analysis from Burning Glass and LinkedIn should be viewed as complementary as there are significant differences in methodologies.

LinkedIn's analysis was based on data compiled using LinkedIn's Economic Graph, which is a unique data set consisting of more than 706 M global members, 50 M companies, 36,000 skills and 90,000 schools. They selected ten APEC economies which have high LinkedIn membership.

Burning Glass Technologies collects job posting data daily to capture employer demand and identify trends across five economies: Australia, Canada, New Zealand, Singapore, and the United States. Job posting data is collected from a wide range of online posting sources and de-duplicated. Burning Glass has a database of more than 1 billion current and historical job postings. In this project Burning Glass analyzed more than 40 million job postings from approximately 45,000 sources, including 18,000 unique skills.

ACKNOWLEDGMENTS

This report was prepared for the APEC Closing the Digital Skills Gap Initiative under a work stream established by the Asia-Pacific Economic Cooperation (APEC) Human Resources Development Working Group (HRDWG). The project is overseen by Mr. Christopher Watson of the U.S. Department of Labor and Ms. Katherine Nunner of Crowell & Moring International.

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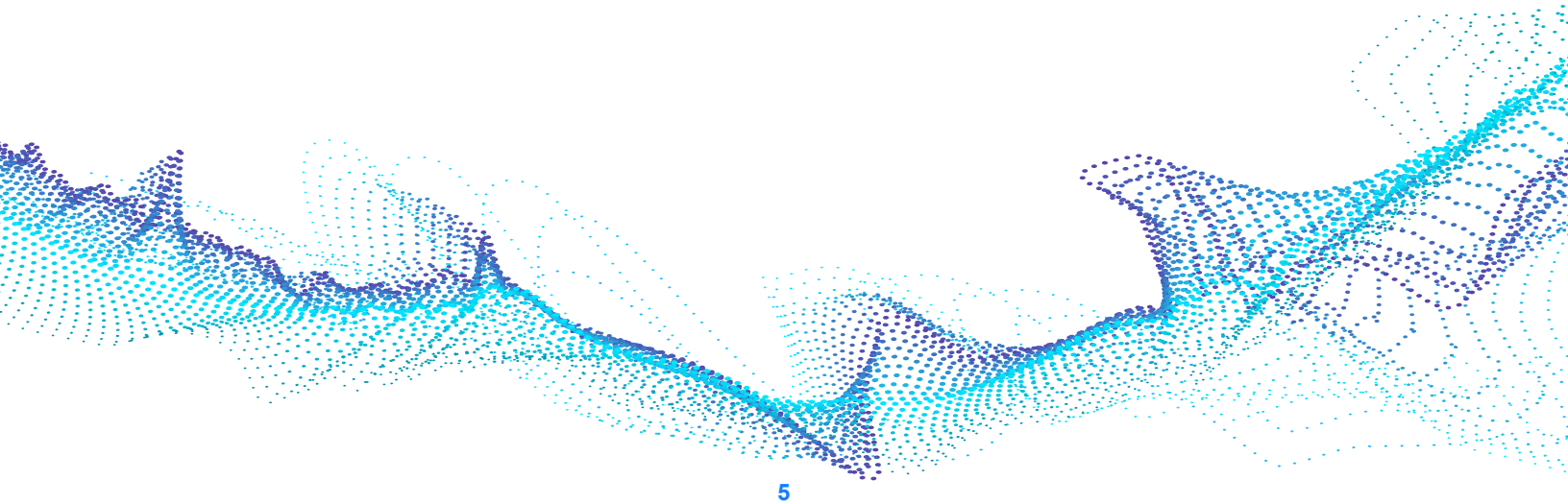


A LinkedIn report for Asia-Pacific Economic Cooperation (APEC)

Closing the Digital Skills Gap Forum 2020

A LinkedIn report for Asia-Pacific Economic Cooperation (APEC)

Introduction

The pace of technological change is disrupting the nature of work and increasing the need for digital skills. What are the trends in hiring digital talent across APEC economies? How does the stock of digital skills compare between economies? And where do we find widening gaps between the supply and demand for digital skills? To answer these questions, we draw insights from LinkedIn's Economic Graph, a digital representation of the global economy consisting of 690M global members, 50M companies, 36,000 skills and 90,000 schools. This dataset offers unique insights into opportunities and challenges for closing the digital skills gap. In this report, we study 10 economies: Australia, Canada, China, Indonesia, Mexico, Malaysia, New Zealand, The Philippines, Singapore and the United States.

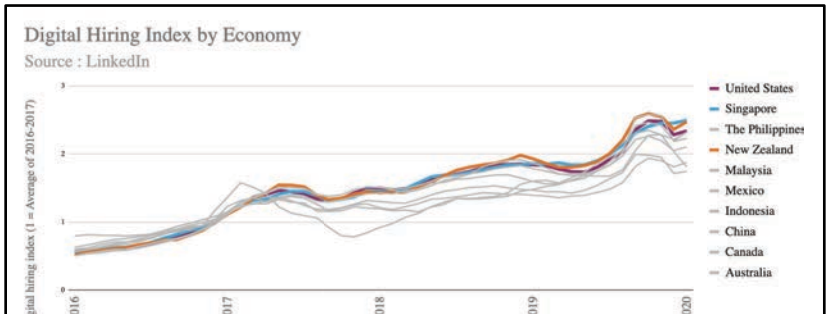
The results of this analysis represent the world seen through the lens of LinkedIn data. As such, it is influenced by how members choose to use the site, which can vary based on professional, social, and regional culture.

Section 1: Hiring trends

In this section, we analyse digital hiring rates, a measure of the demand for digital skills.

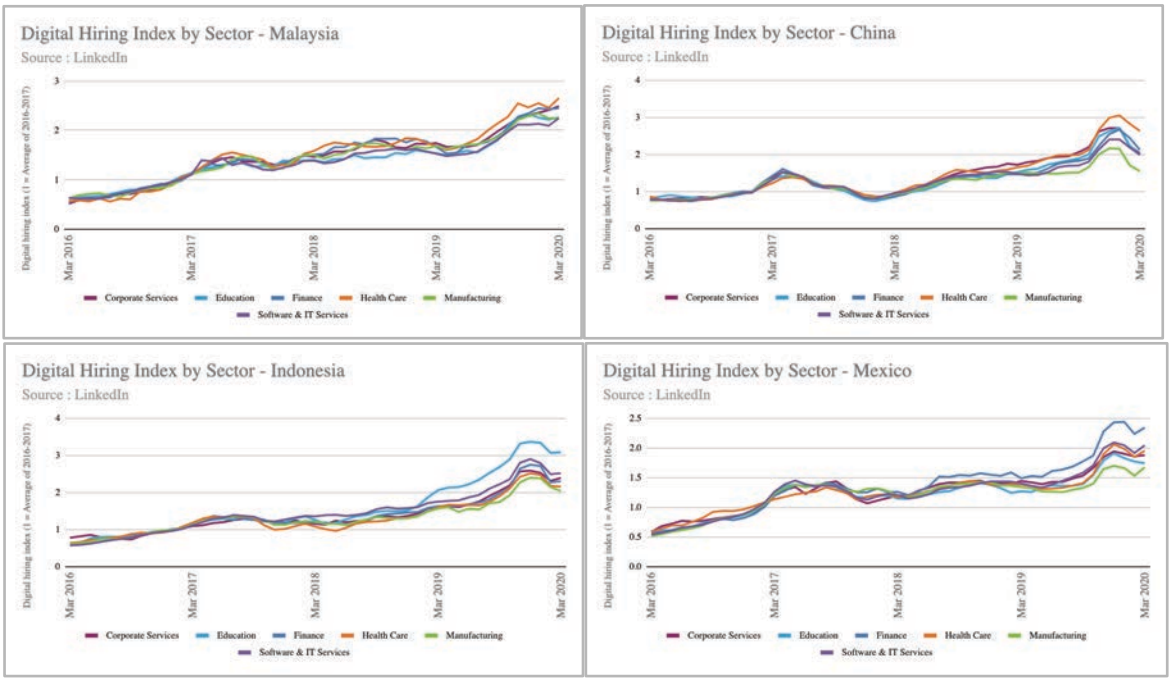
The digital hiring rate is the month-on-month change in the proportion of LinkedIn members with digital skills (as listed on their profile) who also indicate a change in employer. Between 2016 and 2019, this hiring rate increased by an average of 2.6X in the 10 economies. While the global pandemic has led to a hiring slowdown in the first quarter of 2020, we see a continued strong demand for digital talent - the average digital hiring rate in March 2020 was 1.4X higher than in March 2019.

As shown in graph 1, among LinkedIn members, hiring of individuals with digital talent was fastest of the 10 economies, in New Zealand, Singapore and the United States. In New Zealand, the hiring rate between 2016 and 2019 was 2.08x, which means hiring of digital talent was two times larger in 2019 than the 2016-17 average. These trends are consistent across different types of digital skills: basic, applied, software & hardware and disruptive tech skills (detailed graphs for each economy can be found in the annexes).



Graph 1: Digital hiring index rate. Note that x-axis for this graph is a rolling 3-month average.

The demand for digital talent varies by industry and market, suggesting that different sectors are going through different phases of digital transformation in each market. As shown in graph 2, in Malaysia and China, we note an accelerating demand for digital skills in the healthcare sector from mid-2019. Also, starting mid-2018, we observed an acceleration in demand for digital talent in Indonesia for the education sector and in Mexico for the finance sector.



Graph 2: Digital hiring index rate for selected economies. Note that x-axis for this graph is a rolling 3-month average.

Section 2: Skills penetration

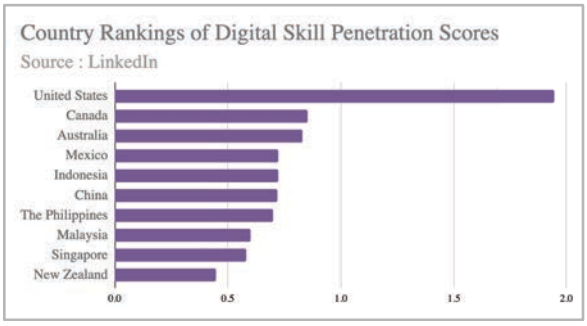
Which economies have the highest penetration of digital skills? The relative skill penetration of digital skills across economies is calculated by comparing the share of digital skills for each economy against the APEC average benchmark based on the same set of occupations. More generally, for a given economy, the relative skill group penetration is the ratio between the penetration rate of a given skill group in each economy and the APEC average penetration rate.

Digital skill penetration by economy, industry and skill type

Analysing 2016-19 pooled results, we note that digital talent diffusion is uneven across economies, digital skill type and industry. As shown in graph 3, at the overall economy level, the US, Canada and Australia emerge as top economies for digital skills penetration.

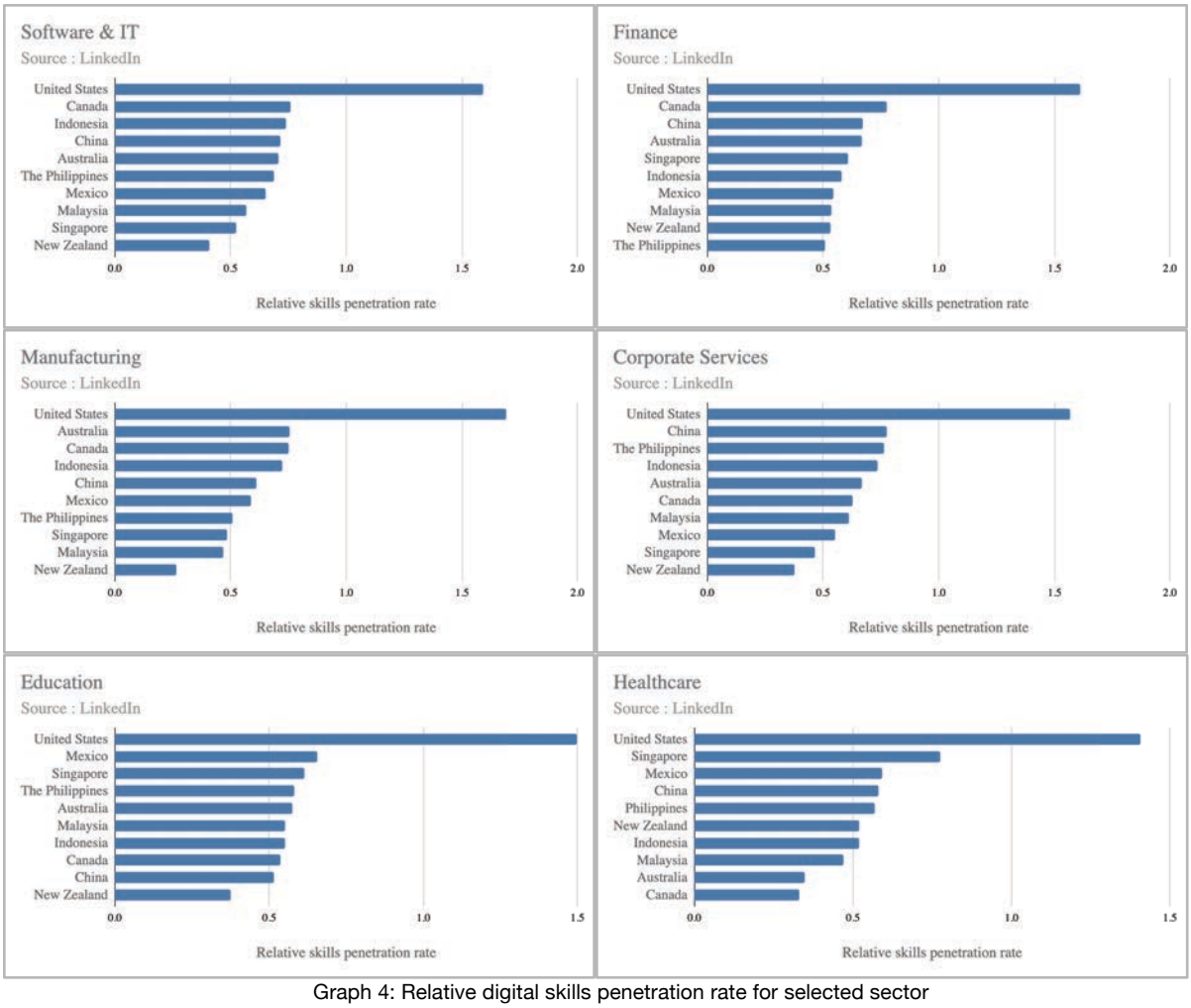
In particular, the average penetration of digital skills in the US is almost 2 times of the overall average for economies in APEC.

It is important to note that this analysis looks only at skills that members have added to their profiles, and results may also reflect economy and cultural differences in how the platform is being used.



Graph 3: Relative digital skills penetration rate

As shown in graph 4, these relative penetration rates can also illustrate the different sectoral strengths of each economy. While the US, Canada and Australia still top the list in many sectors, we see China ranking high in the Finance sector, and likewise Singapore for the Healthcare sector.



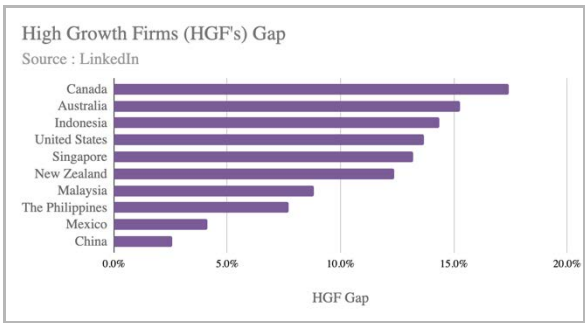
Graph 4: Relative digital skills penetration rate for selected sector

Digital skills in high-growth firms

Firms with a higher proportion of employees with digital skills are more ready to embrace digital transformation. How does the level of digital skills differ based on headcount growth among firms? To answer this question, we calculated the high-growth firm (HGF) gap.

The HGF Gap is the difference between the proportion of employees in HGFs and non-HGF firms with digital skills.

As shown in graph 5, on average, the proportion of employees with digital skills in HGFs is 10% higher than non-HGFs. We also find that high-income economies such as Canada, Australia and the United States have the biggest HGF gaps. This reflects a larger gap that might be a differentiating factor for HGFs in these economies.



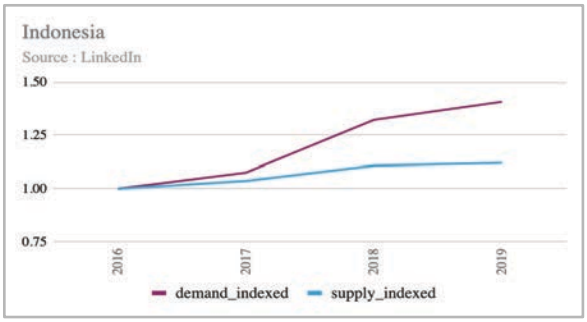
Graph 5: HGF Gap

Section 3: The gap between proportion of members with digital skills (supply) and proportion of job posts requiring digital skills (demand)

In this final section, we analyse trends in digital supply and demand. We analysed trends in the proportion of members who added digital skills to their profile (supply) and the proportion of premium job posts requiring digital skills (demand).

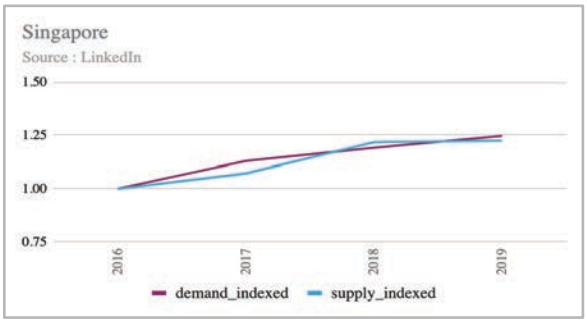
In some developing economies such as China, Indonesia and Mexico, we find demand growing much faster than supply. In other economies, the trend is flat, or supply has outpaced demand. To illustrate these different trends, we are showing graphs from Indonesia, Singapore and Australia below. Detailed graphs for the other economies can be found in the economy annexes.

DEMAND GROWING FASTER THAN SUPPLY



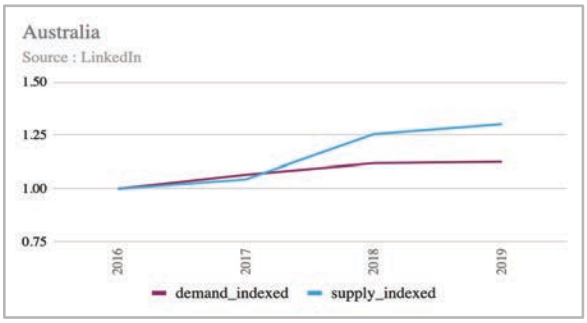
Graph 6: Digital demand and supply for Indonesia

DEMAND & SUPPLY GROWING AT SAME PACE



Graph 7: Digital demand and supply for Singapore

SUPPLY GROWTH HAS OUTPACED DEMAND



Graph 8: Digital demand and supply for Australia

While large differences in supply and demand can have adverse economic effects, closing the skills gap may not be the solution for all economies. In economies with a smaller labour force, governments may aim to narrow the gap or maintain demand higher than supply to fully maximise the talent pool.

burningglass TECHNOLOGIES

A Burning Glass report for Asia-Pacific Economic Cooperation (APEC)

Introduction:

The digitalization of jobs through an increase in digital skill requirements has changed the nature of existing jobs and created entirely new ones.[1] [2] In addition to creating new jobs, digitization has also displaced some workers and forced governments to confront digital skills gaps in their workforces. In this report, Burning Glass Technologies endeavors to understand the state of digitalization that five APEC economies find themselves in using a digitalization index, and to use this understanding to suggest how the economies can tackle the digital skills gap. We use job postings data to measure digitalization in the United States, Canada, Australia, New Zealand, and Singapore. Our analyses revealed five major findings:

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- Basic digital skills are in high demand, are found across many occupations, and are highly transferrable. Across the five economies studied, 26% of all job postings explicitly require at least one baseline digital skill in 2019
- Seven out of ten (69%) of all 2019 job postings in the five economies studied are in digital occupations
- Digitalization and remote work are often interrelated. The more digital skills an occupation requires, the more common it is for remote work to be offered, though the levels vary across economies
- Occupations that are more digital are also likely to pay more than other occupations; we find salary to be positively correlated with digital index score
- Digitalization is fast paced: the least digital occupations in 2013 became more digital at a faster rate than the most digital occupations, and many of the fastest-growing digital skills are increasing rapidly

Overall Trends in Digitalization:

Digital skills are in high demand across occupations. Digital skills can be broken down into baseline digital skills, such as the use of spreadsheet software and computer literacy, and specific digital skills, such as programming languages industry or occupation specific platform familiarity. Both baseline and specific digital skills are in high demand across industries, occupations, and economies.

Baseline skills are important across occupations and form the foundation for more advanced skills. For example, various programs from the Microsoft Office suite, including Microsoft Excel, are in the top three baseline skills required in every APEC economy examined in this report. The diffuse nature of these skills also makes them highly portable across industries and occupations. This implies that investment in baseline digital skills is a profitable endeavor for workers, and a worthwhile focus for workforce development. This is because the return on investment in baseline digital skill will be higher than the investment itself. Baseline skills would be best targeted when skilling or re-skilling workers to prepare them for jobs both today and in the future.

Digitalization is occurring across a range of occupations and industries in these APEC economies. Even in the least digital occupations there are often requirements for some level of digital skills. The acquisition of such skills is a worthwhile endeavor for all workers, not just those in certain professions.

To better understand the state of digitalization in each economy, we use a digitalization index, which considers the various digital skills required by employers and the costs of workers achieving those skills. To create the index, we first generate a list of digital skills and skill groupings that are found in job postings. From there, we calculate the percent of job postings in each occupation that require each digital skill group in each economy. We assign each skill group a weight based on the investment (in time or resources) required for an individual to learn a skill in the skill group, with higher weights for groups that require more investment.[3] We then multiply the weight by the percent of postings requiring each skill group to calculate a digital score for each economy and occupation. Finally, we normalize the scores to be between 0 and 100. We consider an occupation in an economy to be digital if it has a digital index score in the top quartile for that economy, allowing for comparison across economies. Table 1 depicts the index generation process described above.

[1] O'Kane et al. "Digitalization in the German Labor Market." Bertelsmann Stiftung and Burning Glass Technologies, August 2020. https://www.bertelsmann-stiftung.de/en/publications/publication/did/digitalization-in-the-german-labor-market-en

[2] Muro, Mark, Sifan Liu, Jacob Whiton, and Siddharth Kulkarni. "Digitalization and The American Workforce." Brookings, November 2017. https://www.brookings.edu/wp-content/uploads/2017/11/mpp_2017nov15_digitalization_full_report.pdf

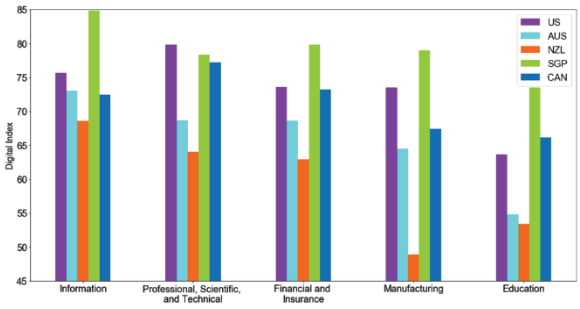
[3] Investment is determined largely based on the average price of a skill, with a higher priced skill being more difficult to learn; so, baseline digital skills have the lowest weight and software development has the highest weight.

Table 1: Skill Groupings for Index Generation

	Digital Skill Grouping	Description	Examples	Weight
Baseline	Baseline	Productivity software	Microsoft Excel, Computer Literacy	0.5
Specific	Customer Relationship Management (CRM)	CRM software	Salesforce, Microsoft CRM	1
	Digital Design and Marketing	Digital production and advertising	Email Marketing, Social Media, Graphic Design	1.5
	Machining and Manufacturing	Machining and engineering software and tools	AutoCAD, 3D Modeling, Computer Numerical Control	2
	Data Analysis	Data analysis tools	R, Stata, Data Science	2.5
	Computer and Networking Support	Set up, support, and manage computer systems and networks	Computer Troubleshooting, Cybersecurity	3
	Software and Programming	Programming languages	Java, Python, SQL, C++	3.5

Digitalization is widespread and has reached most corners of every economy. No longer a feature of a subset of industries, occupations, or skill levels, digital skills are a useful and necessary part of a worker's toolkit. In each economy studied, we see penetration of digital skills across industries, with the economies of the United States, Singapore and Canada leading in all industries examined. Figure 1 shows the digital index scores by industry group across the economies studied.

Figure 1: Comparison of Industry Level Digital Index Scores by Economy



We find that in all economies, it behooves workers to have experience with baseline digital skills. These skills are in demand across industries and occupations, and they are highly transferrable. Twenty-six percent of jobs in 2019 across the five economies explicitly requested a baseline digital skill. While 26 percent might sound low, it is important to note that jobs that are in highly digital occupations often assume knowledge of baseline digital skills and list only those specific digital skills necessary for success in the position. In all, 69 percent of all jobs across the five economies in 2019 were in digital occupations.

As shown in table 2, jobs at all skill levels are often in digital occupations, and as the skill level of the posting increases, so too does the likelihood that the posting is for a digital occupation. Here, we are defining skill level based on the amount of preparation required for a given occupation. Following the O*Net Job Zone classification system for the United States, we classify low skill jobs as those falling in Job Zones 1 and 2, where little preparation to a high school diploma or GED is typically required. A middle skill occupation is equivalent to Job Zone 3, where vocational, on the job, or Associate's level training is required. High skill jobs correspond to Job Zones 4 and 5, where a minimum of a Bachelor's Degree is required for Job Zone 4, and post-Bachelor's education is required for Job Zone 5. This mapping is carried over to all geographies for consistency.

Table 2: Ratio of Digital Jobs by Economy, 2019

Economy	Skill Level	Digital Jobs	Total Jobs	Digital Jobs Ratio
AU	Low Skill	87,800	187,966	47%
AU	Middle Skill	177,214	218,524	81%
AU	High Skill	405,034	480,878	84%
CA	Low Skill	222,785	562,587	40%
CA	Middle Skill	239,118	327,836	73%
CA	High Skill	424,995	448,174	95%
NZ	Low Skill	49,601	102,074	49%
NZ	Middle Skill	33,476	59,862	56%
NZ	High Skill	76,425	85,027	90%
SG	Low Skill	63,552	94,999	67%
SG	Middle Skill	88,541	100,775	88%
SG	High Skill	215,744	224,624	96%
US	Low Skill	3,757,816	10,578,135	36%
US	Middle Skill	6,272,823	8,608,208	73%
US	High Skill	12,476,629	13,701,168	91%

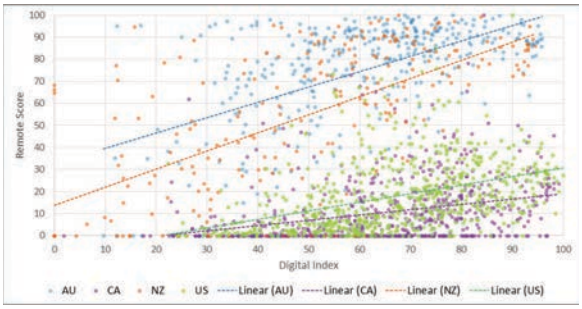
COVID-19 and Digitalization

The data used to produce this report covers the calendar year of 2019, so the impacts of COVID-19 are not reflected in the results. The worldwide pandemic has since caused rapid changes to every economy, with many workers temporarily or permanently separated from employment, and many more transitioning to working remotely. We find that there is a positive correlation in digital index score and the likelihood that a position is advertised as having the capability for remote work when examining jobs from 2019. It is likely that even more positions are now capable of remote work out of necessity.

There is a strong possibility that the COVID-19 pandemic will increase the availability of remote work, as firms who were formerly skeptical of the practice have now had to adapt and embrace it. If remote work proves to be at least similar in productivity to working in a centralized office[4], firms may be more open to the concept even after it is safe to resume social contact.

Figure 2 shows the relationship between digital index scores and the percent of jobs in each occupation that allow remote work. The remote work score, where the numerator is the number of jobs that offer some form of a work from home option explicitly in the job posting divided by the number of jobs that do not allow remote work, sheds some light on the flexibility of occupations, and their openness to the idea of non-centralized working arrangements. Since many jobs that are open to work from home arrangements do not advertise this explicitly in their job postings, the metric calculated here serves as a lower bound for availability of a work from home arrangement. This score, like the digital index, is normalized across countries to be between 0 and 100, where 100 is the highest level of remote work available. In general, the digital index score and the remote work score are positively correlated. Australia and Canada have more remote work opportunities available relative to the United States and New Zealand. Data on remote work for Singapore is not available.

Figure 2: Correlation Between Digital Index and Remote Work



Another impact that we may see due to the COVID-19 pandemic is more workers needing to be reskilled to achieve gainful employment. Workers who have become permanently displaced and now must search

[4] It is worth noting that remote work under pandemic conditions is not necessarily comparable to remote work in other times due to childcare and other factors.

for a new position will find it beneficial, if not necessary, to have at least baseline digital skills. We see through analysis of jobs that there are many baseline digital skills that are in demand across occupations. These digital skills would be a strong starting point in a reskilling effort in a post-COVID-19 world.

As workers and companies are forced to change the way work is done, digitalization and a reliance on digital skills may increase faster than they would have without the pandemic. Workers may need to augment their skillset to be able to work efficiently and effectively in this new environment.

Digital skills are correlated with rising inequality that has come about during the COVID-19 pandemic. In occupations where digital skills and remote work are the norm, workers are likely less impacted by lockdowns and other restrictions intended to stem the spread of the virus. Workers who are displaced during the pandemic can leverage digital skills that they already have, and gain additional skills so that they are suited for occupations and industries that are better enduring the changes in work environments brought about by the pandemic. While digital skills are useful for remote work, they are also useful for transitioning to work that is outside of front line and service sector positions, to occupations where compensation is higher and the likelihood of drastic impacts from social distancing may be less.

Virus experts postulate that there may be continuing intensity of the spread of the virus.[5] If this does occur, another round of restrictions could be implemented. Those occupations that were affected most in the first wave of restrictions, predominantly front-line service sector type positions, would be in the crosshairs again, and these occupations are generally the least digital, so these displaced workers may be less likely to have digital skills that can be transferred to another occupation.

The occupations that have changed the most regarding their reliance on digital skills between 2013 and 2019 are the occupations that had the lowest digital index scores in 2013. This suggests that the least digital occupations are becoming more digital at quite a fast pace. This trend of digitalization suggests that digital proficiencies are useful for nearly all occupations, and workers may benefit in compensation and job opportunities if they gain digital skills.

Conclusions and Outlook:

Digitalization is a prevailing force in all economies studied in this report. Some economies, such as Singapore and Canada experience very high rates of digitalization as measured by several metrics, while others, such as New Zealand, have experienced slower rates of digitalization. However, the trend of digitalization and the creative destruction that comes along with it has taken place at least to some extent in each economy examined.

This research finds that baseline digital skills are critical for most workers and that even the least digital occupations are becoming more digital over time. As workers are displaced by changes caused by digitalization, or fresh workers come of age they should be equipped with digital skills so that they can thrive in the workforce. Baseline digital skills are diffuse and transferrable, and their requirement spans industry and occupation.

In a world gripped by the COVID-19 pandemic, digital skills and remote work have become critical to retaining employment and to economic survival. As remote work becomes the only option for many occupations, we find that some economies were more open to remote work prior to the pandemic than others. This may prove to allow these economies to have a better transition and outcome as the virus forces a new normal on workers. In all economies studied, occupations that were least open to remote work were also the least digital. This may deepen inequality if workers in these non-digital occupations are laid off or furloughed and do not have the digital skills necessary to transition to other employment that is still functioning under COVID-19 restrictions.

The COVID-19 pandemic may increase the rate of digitalization. In all economies, it is important for workers to possess digital skills so that they can find gainful employment, now and in the future. This warrants significant public policy efforts to train and re-train workers, and to prepare students for the labor market that they will one day face.

[5] University of Washington Institute for Health Metrics, https://covid19.healthdata.org/

LinkedIn methodology and economy insights

Annex 1: Methodology

This annex provides additional detail on the methodologies in the report.

Data source
The analysis is based on data from LinkedIn's Economic Graph, a unique dataset consisting of 690M global members, 50M companies, 36,000 skills and 90,000 schools.

For digital hiring rate, the analysis is based on data trends from 1 January 2016 - 31 March 2020. For digital skills penetration and supply-demand data the analysis is based on the trends from 1 January 2016 - 31 December 2019.

Economy selection
This report includes 10 economies: Australia, Canada, China, Indonesia, Mexico, Malaysia, New Zealand, The Philippines, Singapore and the United States. To ensure representativeness and reduce noise in our data, we chose economies with at least 20% of their total workforce on LinkedIn.

It should be noted that China is included in this sample due to their increasing importance in the global economy, but LinkedIn coverage in these economies does not reach the 20% of the workforce. Insights for these economies may not provide as full a picture as other economies and should be interpreted accordingly.

Definition of digital skills
LinkedIn's Economic Graph consists of 36,000 distinct, standardised skills. LinkedIn members self-report their skills on their LinkedIn profiles, which are then coded and classified by taxonomists at LinkedIn into skill groups. For example, Python and C++ are grouped into a development tool skill group, and online marketing and search advertising are grouped into a digital marketing skill group. A detailed list of skills and their corresponding skill groups can be found in Annex 2. In a collaborative effort between LinkedIn and the World Bank, some of these skill groups have been further classified as Tech Skills and Disruptive Tech Skills [Data Insights : Jobs, Skills and Migration trends methodology & validation results][1]

In this report, we define "digital skills" in four categories:

- Basic tech skills: Digital literacy skills to access email and basic applications such as Microsoft Office.
- Applied tech skills: Skills that require using enterprise softwares and platforms to improve job efficiency and performance, such as SAP ERP and social media.
- Software & hardware tech skills: Skills related to building software and hardware, such as mobile app development and printed circuit board (PCB) design.
- Disruptive tech skills: Skills required for designing and developing new technologies, such as artificial intelligence and robotics.

Digital Hiring Rate and Digital Hiring Index
The Digital Hiring Rate is the number of LinkedIn members with any digital skill listed on their profile and who added a new employer to their profile in the same month the new job began, divided by the total number of LinkedIn members who have listed at least one skill on their profile in the economy. By focusing our analysis on the timeliest data, we can make month-to-month comparisons and account for any potential lags in members updating their profiles.

This rate is then indexed to the average month in 2016-2017 to arrive at the **Digital Hiring Index**. For example, an index of 1.05 indicates a hiring rate that is 5% higher than the average month in 2016-2017.

Relative Skill Penetration
The Relative Skill Penetration Rate compares how prevalent digital skills are for each economy against an average benchmark, based on the same set of occupations in each economy. For this report, we are using the average of all APEC economies as the benchmark.

In order to compute this metric, we first calculate a weight for each skill based on the prevalence of that skill in a particular segment, such as a particular geography, sector, and/or occupation, and compare it to other segments of the labor market.

1. First, all members who hold the occupation during the relevant period are included in the analysis.
2. Next, a frequency measure is assigned to each skill by calculating the number of times members list the skill under the "skills" section of their LinkedIn profile. Note that

[1] World Bank Group-LinkedIn Data Insights : Jobs, Skills and Migration Trends Methodology and Validation Results (English). Washington, D.C. : World Bank Group.

skills are only included in the analysis if they were specifically added during the period for which the individual has held that position. The skills that are added by fewer than or equal to 10 members during the pre-defined period are dropped to reduce 'noise' in the skills data. Skills are only captured if they are relevant to the role and enables a comparison between skills profiles over time.

3. Finally, each occupation-skill pair is weighted following a term frequency–inverse document frequency (TF-IDF) model: skills that are generic and appear in multiple occupations are down-weighted. The result is a list of skills that are most representative of that occupation in that economy.

Using the list of skills that are most representative of each occupation in each sector and economy, we calculate the **Relative Skill Penetration Rate** in the following steps:

1. Identify top 50 skills in each occupation in each economy: use the TF-IDF approach to give higher weights to skills that are added by more members and are more unique for each occupation.
2. Calculate penetration rates by dividing the number of digital skills over the total number of skills for each occupation and each economy.
3. Calculate relative penetration rates by taking the ratio between the average penetration rates across all occupations in a given economy, and the APEC average penetration rate of digital skills across all the APEC economies for the same set of occupations.

High-Growth Firms

We define High-Growth Firm (HGF) as firms that meet both of the following criteria:

- Headcount growth of at least 20% on average, over the last three years. This follows the definition from the Organisation for Economic Co-operation and Development (OECD). We compute headcount growth from historical LinkedIn members' positions. This metric does not adjust for platform penetration growth bias over time. However, approximately 80% of US regions experienced less than 1% standard deviation in annual membership growth in 2017-2019.
- Company size of at least 10 employees. Company size is computed from LinkedIn member headcount at the time we pulled data. We also compared data on company pages.

Supply and demand

We calculated Indexed Supply Trend in the following steps:

1. For each year, we first calculated the proportion of members with digital skills over the total number of members who list any skill within the same time period.
2. Next, we index the numbers to the average of 2016's number, to get the trend over time.

We calculated Indexed Demand Trend in the following steps:

1. For each year, we first calculated the proportion of posted jobs requiring digital skills over the total number of posted jobs within the same time period.
2. Next, we index the numbers to the average of 2016's number, to get the trend over time.

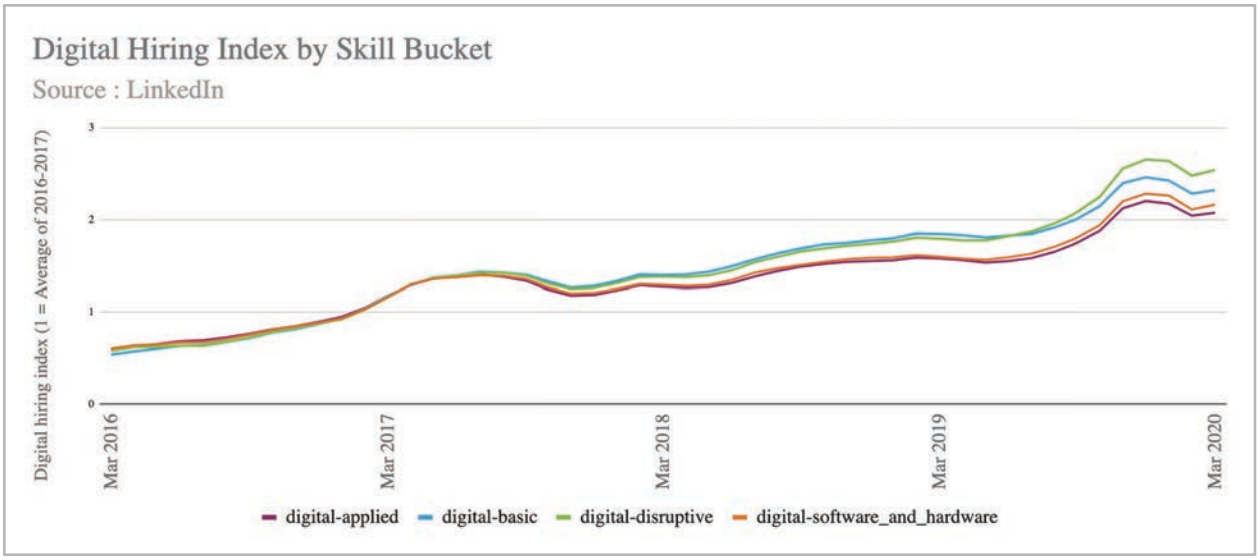
Annex 2: Digital skill bucket to skill group mapping

DIGITAL SKILL BUCKET	SKILL GROUP
Basic	Digital Literacy
Applied	Technical Support, Animation, Computer Graphics, Digital Marketing, Enterprise Software, Graphic Design, Information Management, Social Media, System Administration
Software & Hardware	Computer Hardware, Computer Networking, Data Storage Technologies, Game Development, Mobile Application Development, Product Development, Scientific Computing, Signal Processing, Software Development Life Cycle (SDLC), Software Testing, Web Development
Disruptive	Development Tools, Artificial Intelligence (AI), Cybersecurity, Data Science, FinTech, Human Computer Interaction, Materials Science, Nanotechnology, Robotics, Aerospace Engineering, Genetic Engineering

Annex 3: Additional Visuals

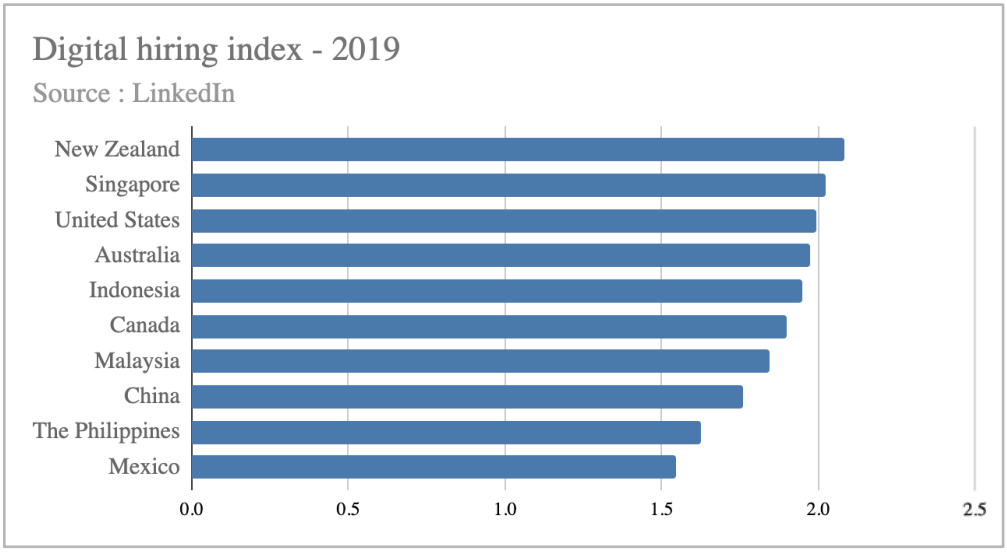
This annex provides additional visuals on the insights discussed in the report.

A1: Overall digital hiring index by digital skills bucket



Digital hiring index rate for the 4 digital skills buckets. Note that x-axis for this graph is a rolling 3-month average.

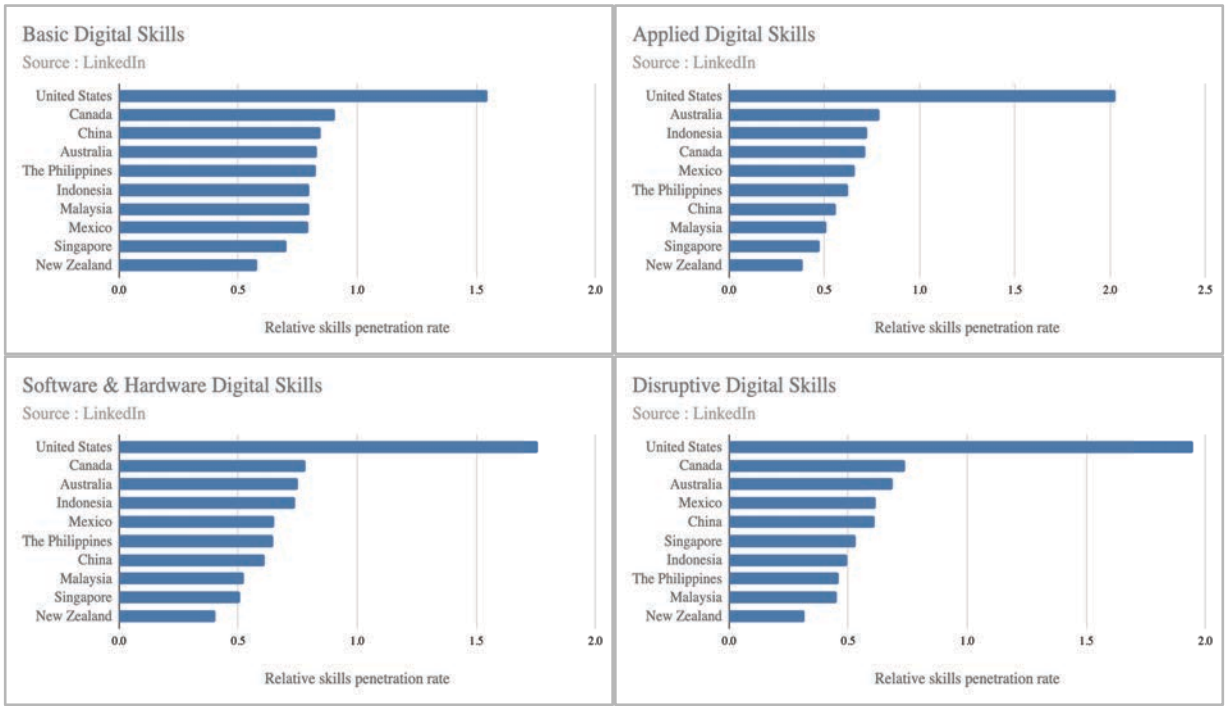
A2: Economy ranking based on the digital hiring index 2019



Digital hiring index rate - 2019

A3: Relative digital skills penetration rate by bucket

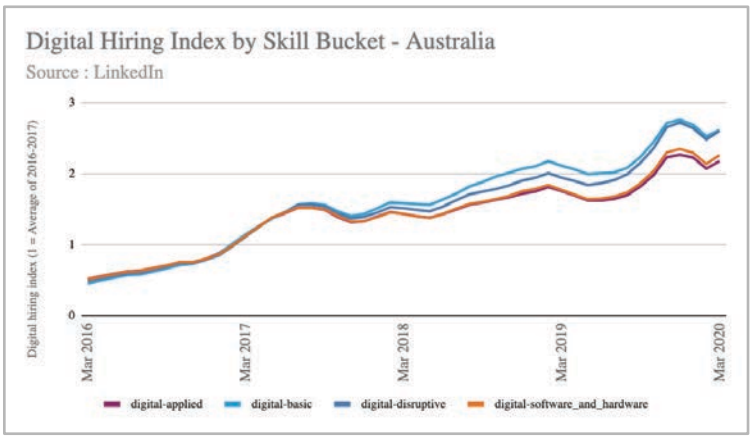
Digital economies require individuals to have baseline digital skills, as well as develop talent with disruptive skills to build and run sophisticated technology systems. To better understand digital maturity by economy, we analysed relative skill penetration in four digital skill types: (a) basic skills, (b) disruptive skills, (c) applied skills and (d) software and hardware skills.



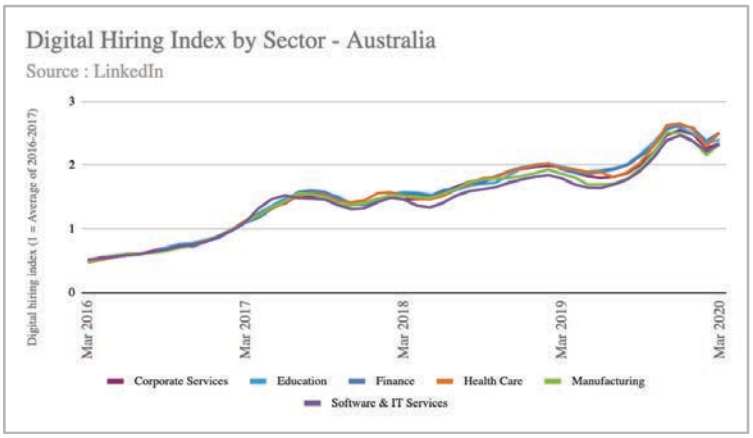
Relative digital skills penetration rate for different skill buckets

Annex 4: Economy Profiles

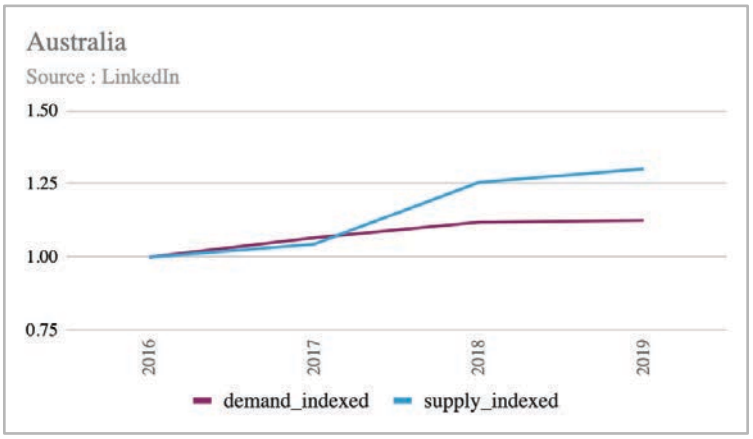
A4.1: Australia



A4.1 - Graph 1: Digital hiring index rate for the 4 digital skills buckets. Note that x-axis for this graph is a rolling 3-month average.

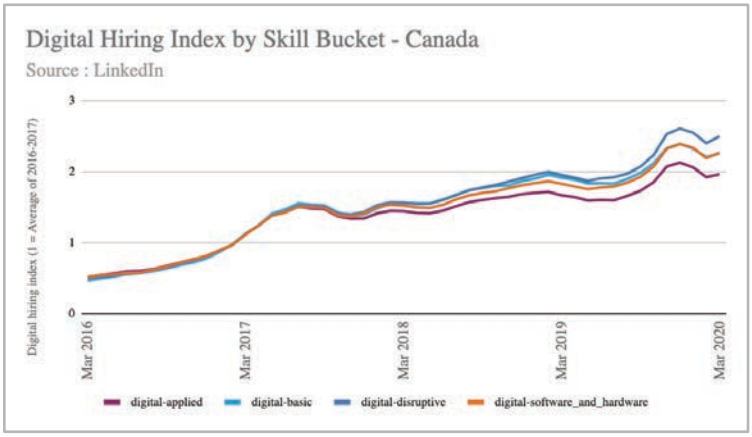


A4.1 - Graph 2: Digital hiring index rate at sector level. Note that x-axis for this graph is a rolling 3-month average.

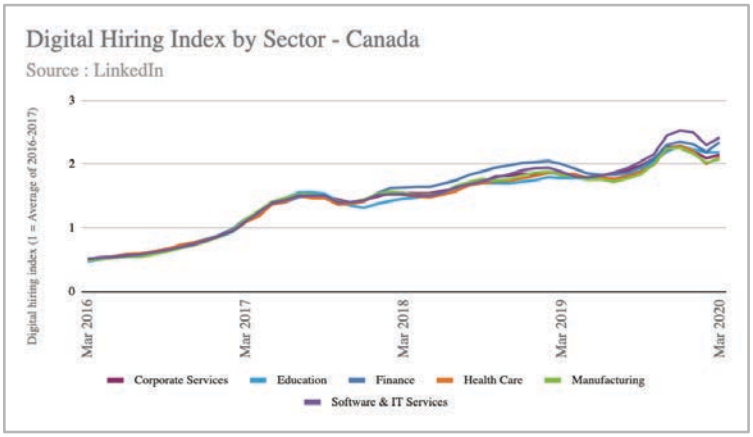


A4.1 - Graph 3: Digital supply and demand

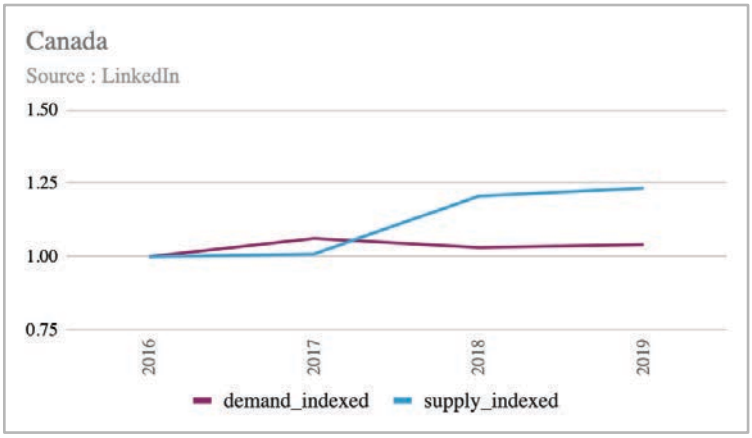
***A4.2**: Canada*



A4.2 - Graph 1: Digital hiring index rate for the 4 digital skills buckets. Note that x-axis for this graph is a rolling 3-month average.

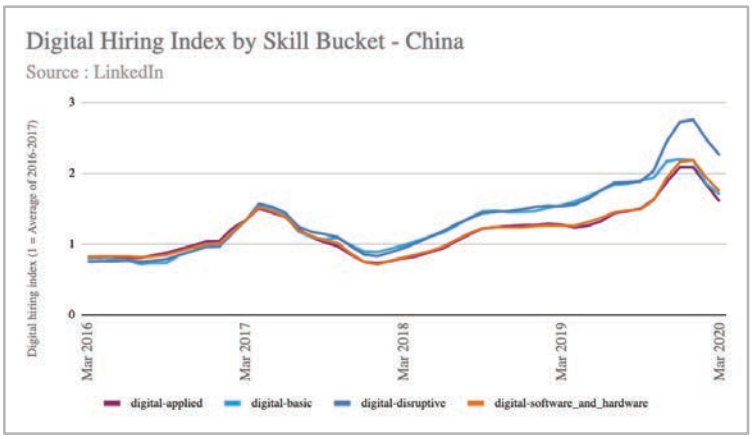


A4.2 - Graph 2: Digital hiring index rate at sector level. Note that x-axis for this graph is a rolling 3-month average.

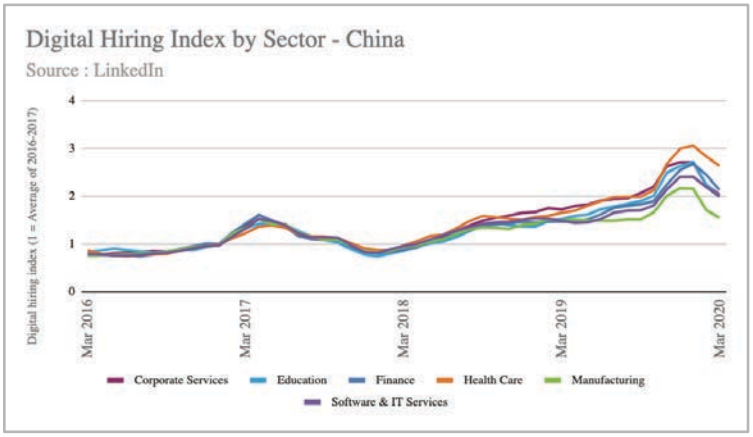


A4.2 - Graph 3: Digital supply and demand

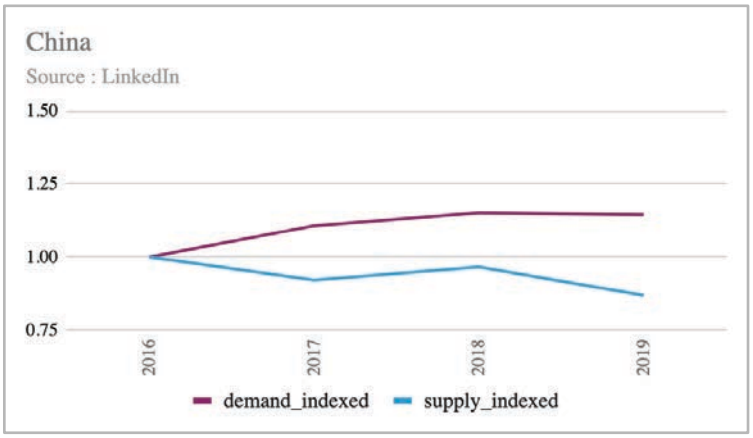
***A4.3**: China*



A4.3 - Graph 1: Digital hiring index rate for the 4 digital skills buckets. Note that x-axis for this graph is a rolling 3-month average.

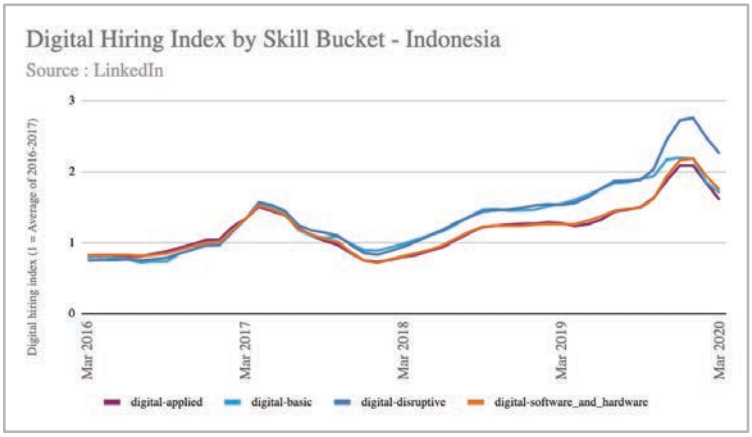


A4.3 - Graph 2: Digital hiring index rate at sector level. Note that x-axis for this graph is a rolling 3-month average.

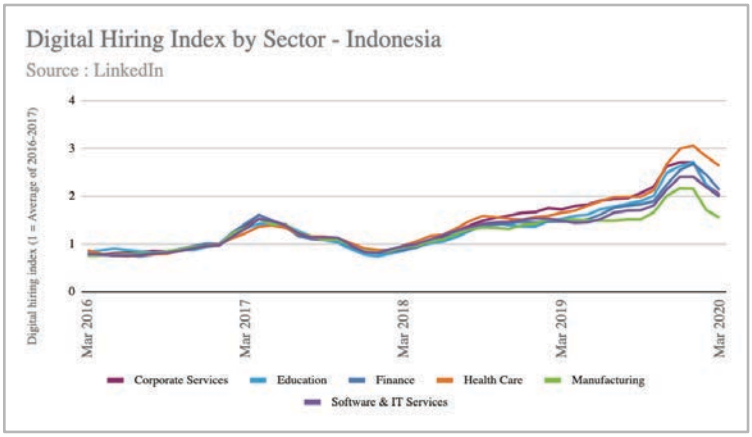


A4.3 - Graph 3: Digital supply and demand

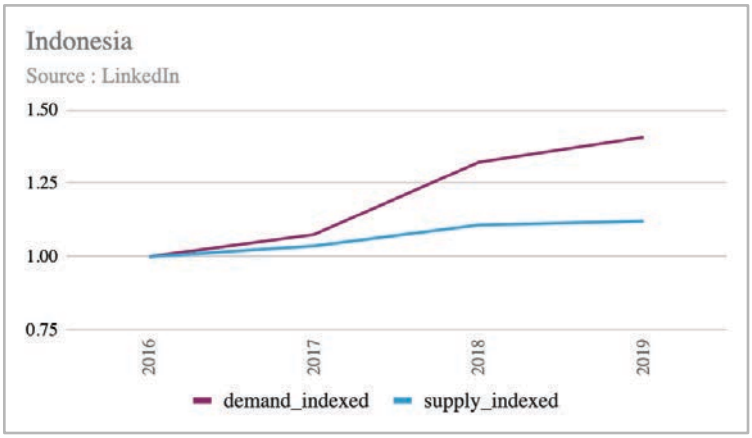
***A4.4**: Indonesia*



A4.4 - Graph 1: Digital hiring index rate for the 4 digital skills buckets. Note that x-axis for this graph is a rolling 3-month average.

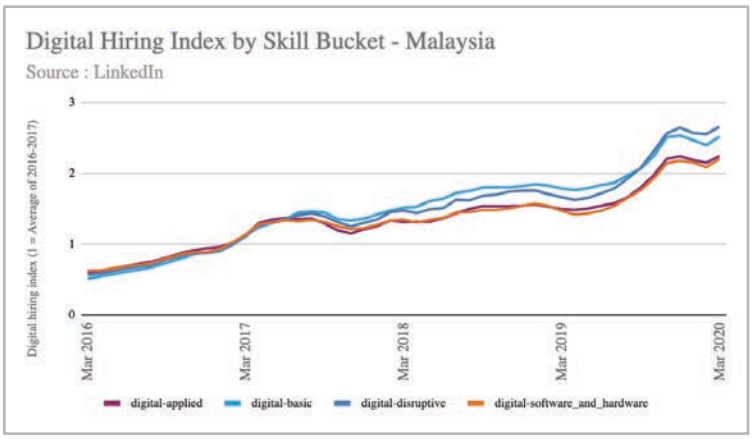


A4.4 - Graph 2: Digital hiring index rate at sector level. Note that x-axis for this graph is a rolling 3-month average.

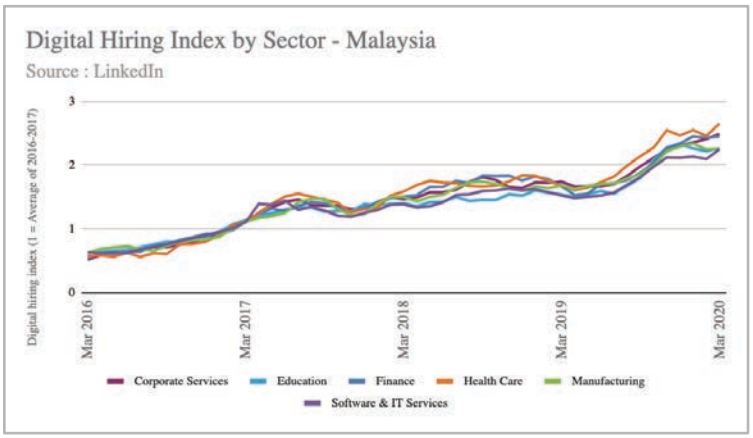


A4.4 - Graph 3: Digital supply and demand

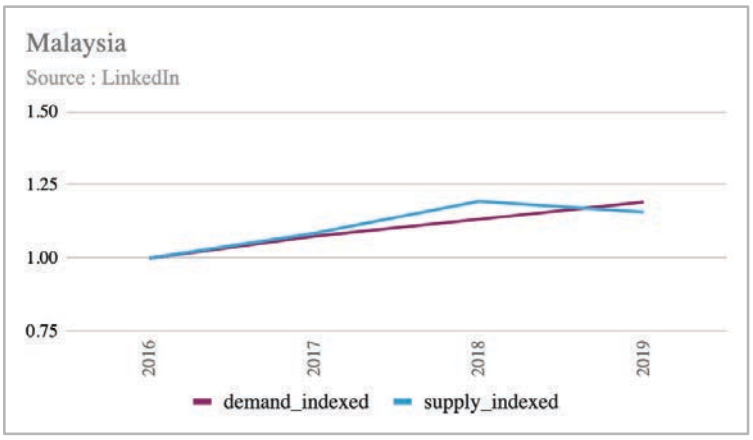
***A4.5**: Malaysia*



A4.5 - Graph 1: Digital hiring index rate for the 4 digital skills buckets. Note that x-axis for this graph is a rolling 3-month average.

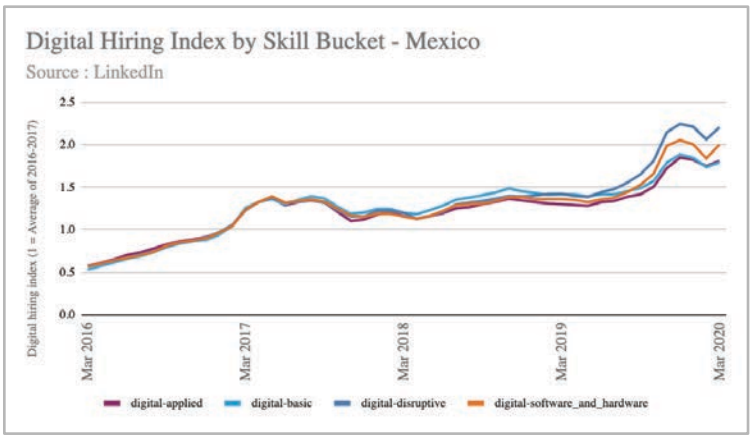


A4.5 - Graph 2: Digital hiring index rate at sector level. Note that x-axis for this graph is a rolling 3-month average.

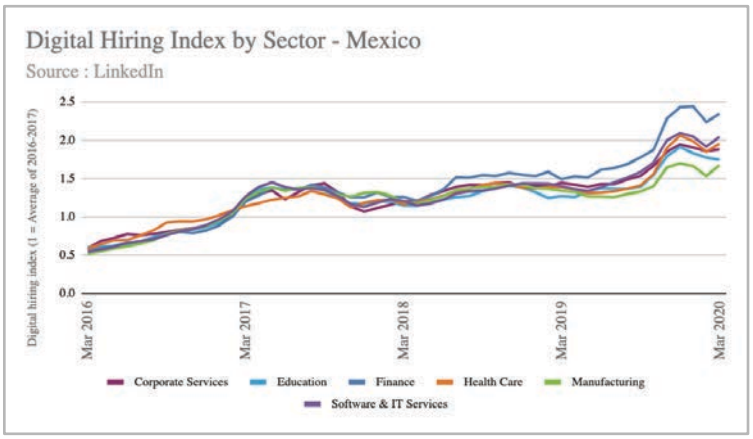


A4.5 - Graph 3: Digital supply and demand

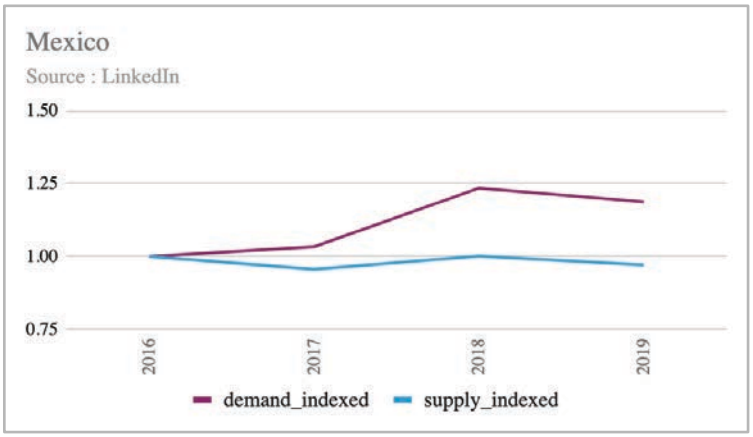
***A4.6**: Mexico*



A4.6 - Graph 1: Digital hiring index rate for the 4 digital skills buckets. Note that x-axis for this graph is a rolling 3-month average.

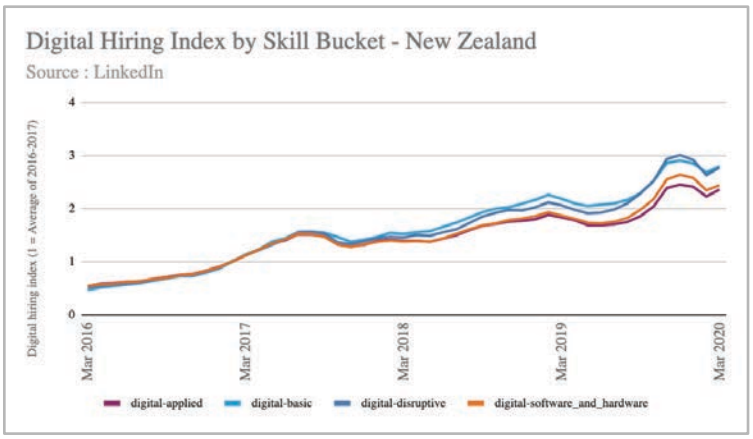


A4.6 - Graph 2: Digital hiring index rate at sector level. Note that x-axis for this graph is a rolling 3-month average.

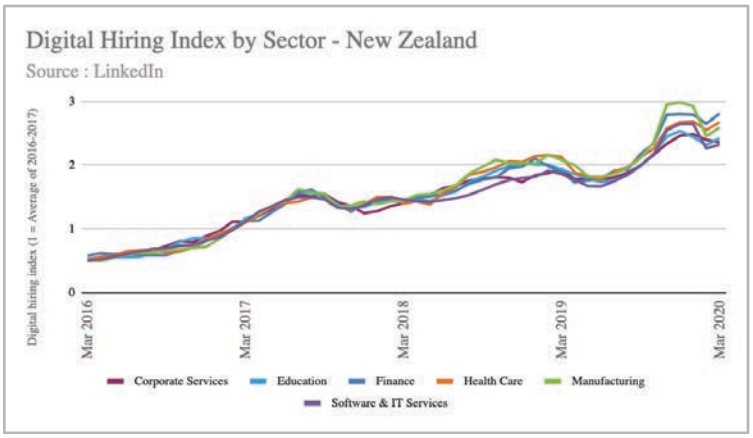


A4.6 - Graph 3: Digital supply and demand

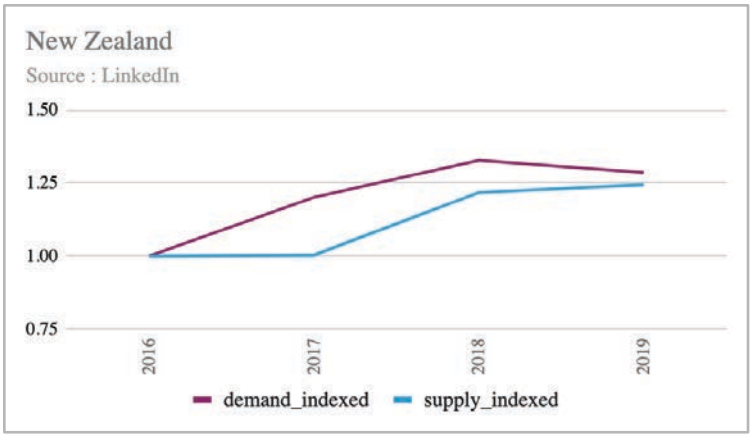
***A4.7**: New Zealand*



A4.7 - Graph 1: Digital hiring index rate for the 4 digital skills buckets. Note that x-axis for this graph is a rolling 3-month average.

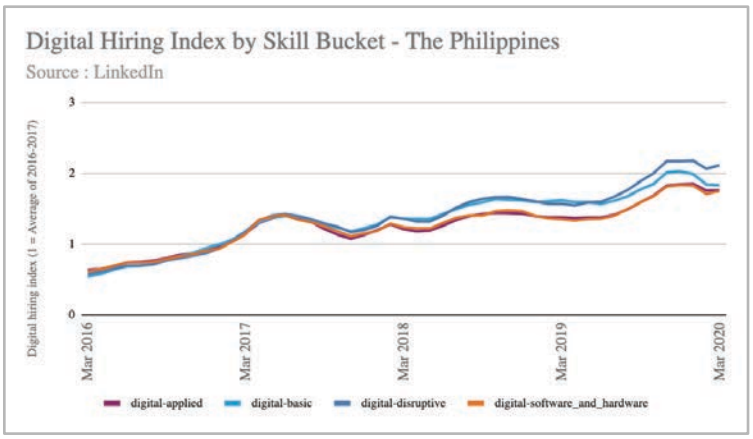


A4.7 - Graph 2: Digital hiring index rate at sector level. Note that x-axis for this graph is a rolling 3-month average.

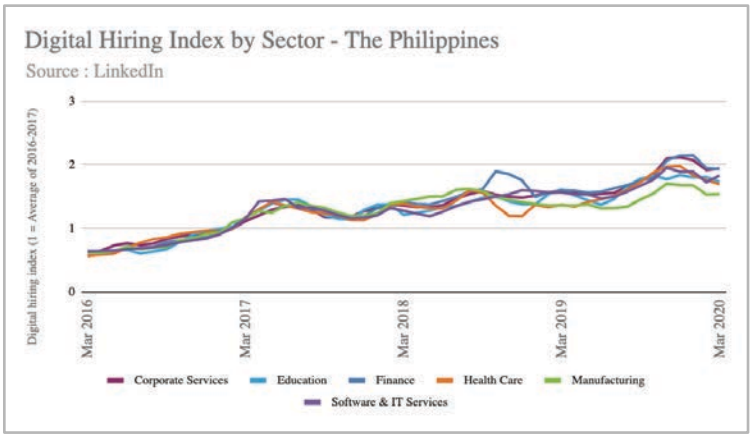


A4.7 - Graph 3: Digital supply and demand

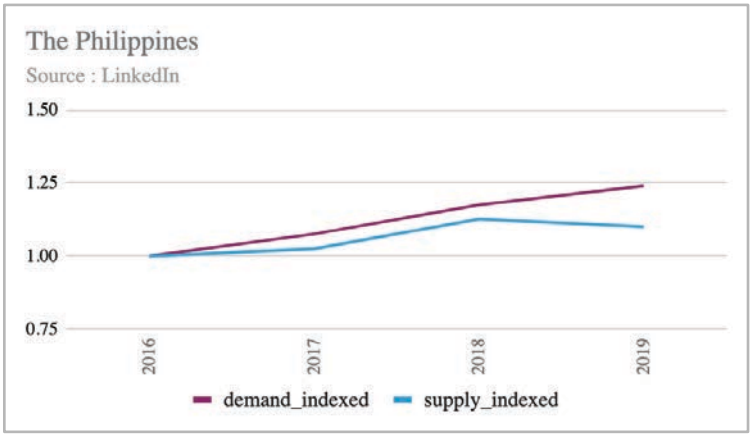
***A4.8**: The Philippines*



A4.8 - Graph 1: Digital hiring index rate for the 4 digital skills buckets. Note that x-axis for this graph is a rolling 3-month average.

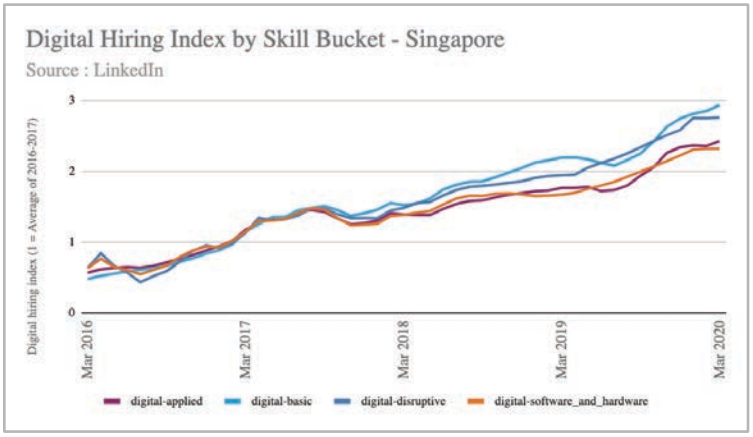


A4.8 - Graph 2: Digital hiring index rate at sector level. Note that x-axis for this graph is a rolling 3-month average.

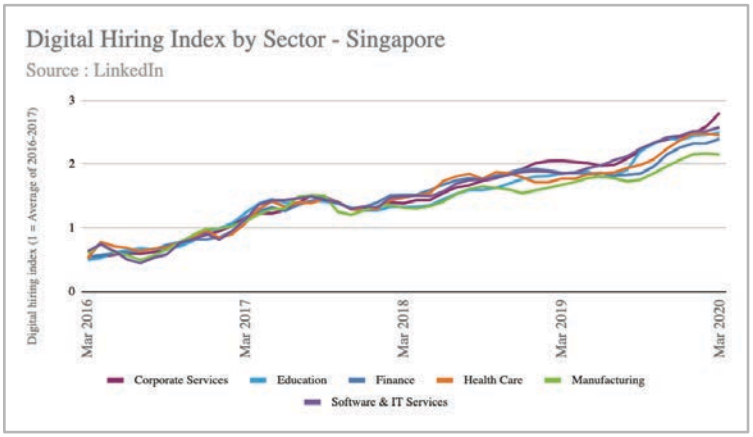


A4.8 - Graph 3: Digital supply and demand

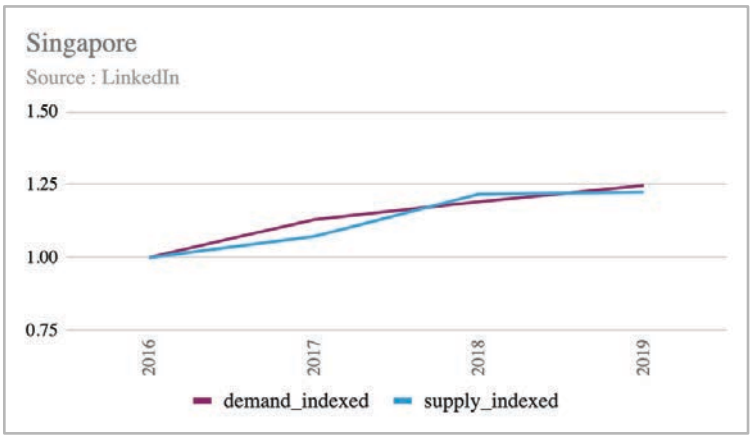
***A4.9**: Singapore*



A4.9 - Graph 1: Digital hiring index rate for the 4 digital skills buckets. Note that x-axis for this graph is a rolling 3-month average.

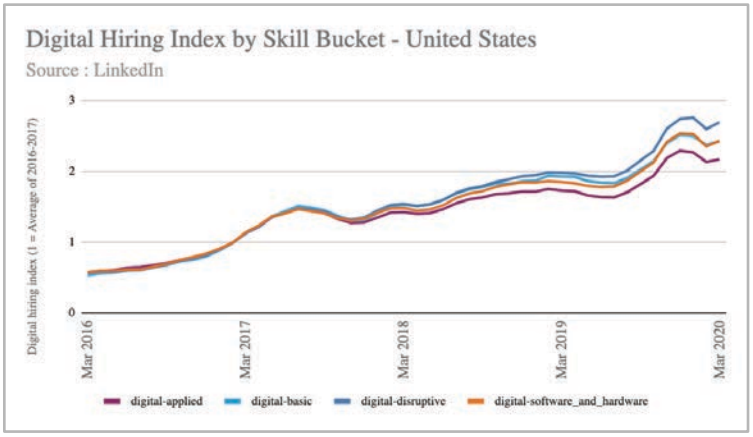


A4.9 - Graph 2: Digital hiring index rate at sector level. Note that x-axis for this graph is a rolling 3-month average.

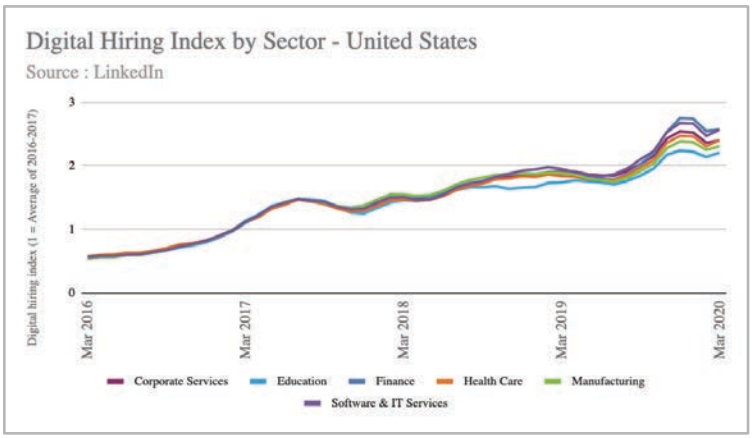


A4.9 - Graph 3: Digital supply and demand

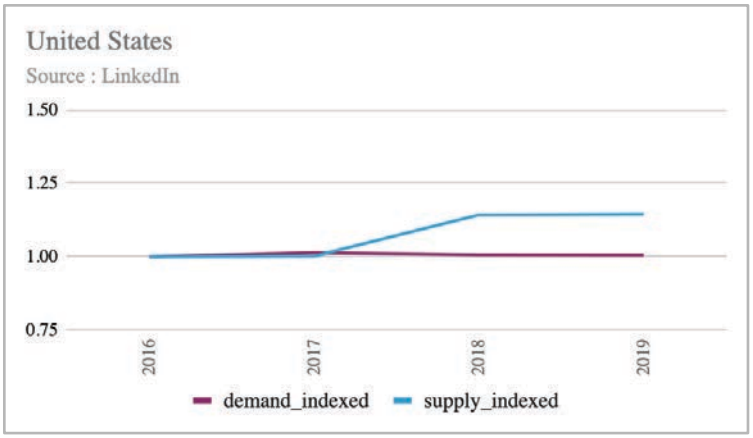
A4.10: *United States*



A4.10 - Graph 1: Digital hiring index rate for the 4 digital skills buckets. Note that x-axis for this graph is a rolling 3-month average.



A4.10 - Graph 2: Digital hiring index rate at sector level. Note that x-axis for this graph is a rolling 3-month average.



A4.10 - Graph 3: Digital supply and demand

burningglass TECHNOLOGIES

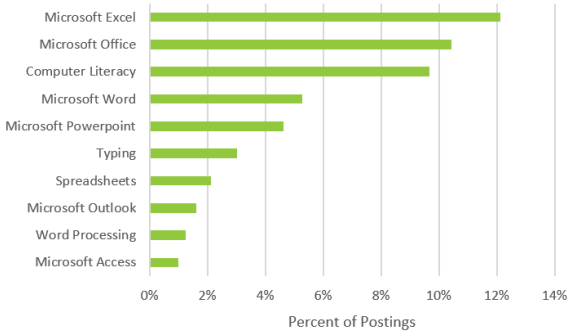
A Burning Glass methodology and economy insights

United States of America:

The United States economy is largely dependent on digital skills at all skill levels, with skill level defined based on the general amount of preparation required for a given occupation. From Table 2, we see that in the United States economy there is diffusion of digital skills across occupational skill levels.

Figure 3 depicts the top requested digital baseline skills, with the most requested, Microsoft Excel, being explicitly named in roughly 12 percent of all jobs in the United States economy in 2019.

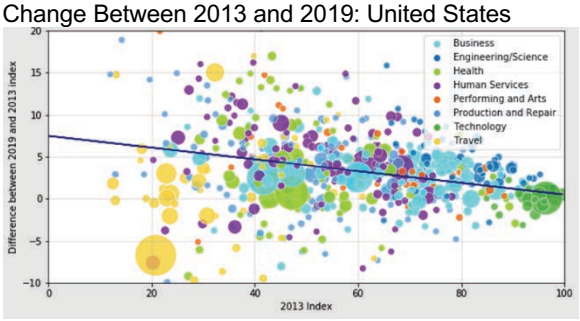
Figure 3: Digital Baseline Skills in Highest Demand: United States, 2019



The top requested digital specialized skills are not as widely requested as their baseline counterparts, likely because the use and acquisition of these skills are more occupation, industry or firm specific. Use of specialized software for client relationship management, or a specific programming language is likely to be something that a worker with a solid basis in digital skills can pick up through on the job or short-term certificate training based on their own very specific needs. There are still patterns to note among the top specific digital skills are the programming languages of SQL, Python and Java, and other digital skills such as software development, social media, and technical support. These are used across industries, so they are more likely to be portable than some other specialized skills, though still less so than baseline skills.

Figure 4 shows the correlation between an occupation's digital index in 2013, and the difference in index scores between 2013 and 2019.

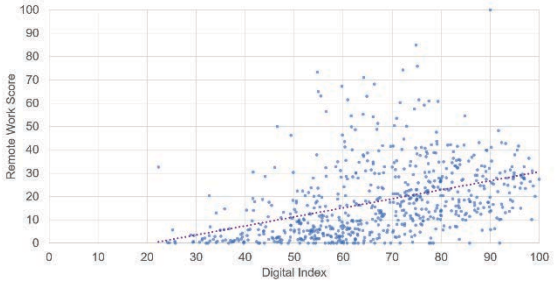
Figure 4: Correlation of Current Digital Index to Change Between 2013 and 2019: United States



There is a clear negative relationship between the current digital index score and the change over time, indicating that the least digital occupations in 2013 are the ones that have changed the most.

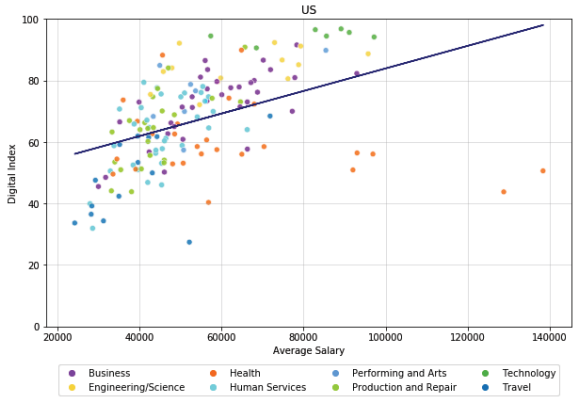
In the United States, as in the other economies examined, there is a positive relationship between the digital index score of an occupation and that occupation's remote work score. However, the relationship is less pronounced than those in other economies. This suggests two things: prior to the COVID-19 pandemic, there was relatively low openness to remote work, so there was likely a more severe impact on work brought about by the COVID-19 restrictions. More importantly, workers in occupations with relatively low digital index scores are also very unlikely to be able to work remotely. Given the reliance of so many occupations on digital skills, the workers from non-digital occupations who were displaced by the shuttering of businesses were likely less well equipped to transition into occupations less affected by the pandemic restrictions.

Figure 5: Correlation Between Digital Index and Remote Work: United States, 2019



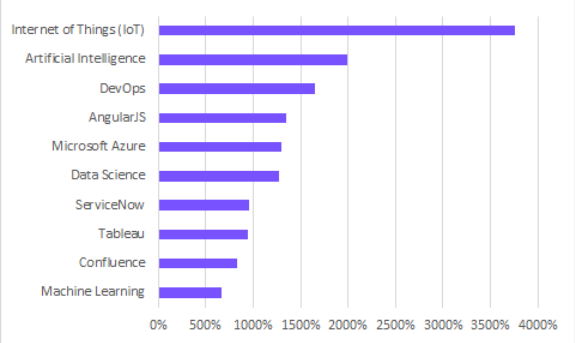
The least digital occupations are likely to be those with lower skilled and lower paid workers, so when social distancing guidelines were put in place these workers were both the most vulnerable financially and the least able to adapt

Figure 6: Digital Index and Minimum Advertised Salary by Occupation: United States, 2019



Looking at the top ten digital skills by growth rate between 2013 and 2019 in the United States, we see large increases of over 500 percent. This suggests a rapidly changing digital landscape over a relatively short period of time.

Figure 7: Growth Rate of the Fastest Growing Digital Skills: United States, 2013 - 2019



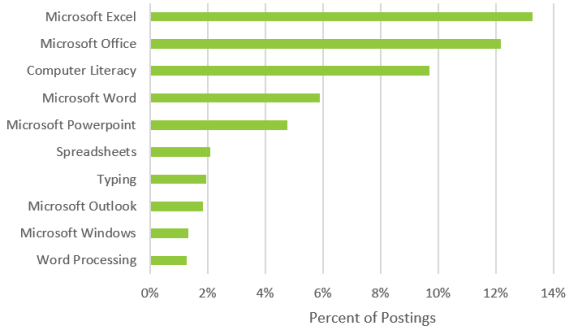
The fastest growing digital skills are growing at a breakneck pace and are all specialized skills. These skills represent the frontier of digital skills, and are likely to keep changing as new technologies are created..

Canada:

The digital index scores in the Canadian economy are high relative to other economies because most occupations in Canada require at least one digital skill.

Like other economies examined, the most requested baseline digital skills in the Canadian economy are centered around Microsoft products such as Excel and PowerPoint, as well as basic computer use and literacy. The percent of jobs that request these skills is relatively high relative to other economies examined in this report. Figure 8 shows the top requested baseline digital skills and the percent of jobs in the Canadian economy that require them. These skills are diffuse, and they are portable, rendering them worthwhile of investment by many types of workers.

Figure 8: Digital Baseline Skills in Highest Demand: Canada, 2019



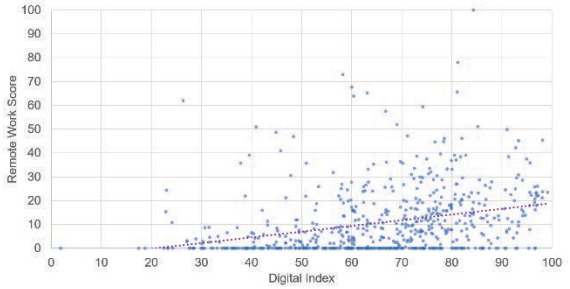
As expected, the top requested digital specialized skills are not requested at such high rates as the baseline skills. Specialized skills are often more specific to occupations or industries, and therefore are less widely portable. Still, the top requested specialized skill, SQL, is requested in over 2% of all jobs in 2019.

In the Canadian economy, there is a negative relationship between an occupation's 2013 digital index score and the change in that score between 2013 and 2019. The least digital jobs are the ones that have seen the greatest increase, further underscoring the idea that all workers should possess digital skill competencies as the economy moves forward.

Figure 9: Correlation of Current Digital Index to Change Between 2013 and 2019: Canada

The COVID-19 pandemic has made remote work a thing of necessity, and possibly hastened a trend that was already in the making in some parts of many economies. In Canada, the relationship between an occupation's digital index and its remote score is the least positive of all economies considered in this report.

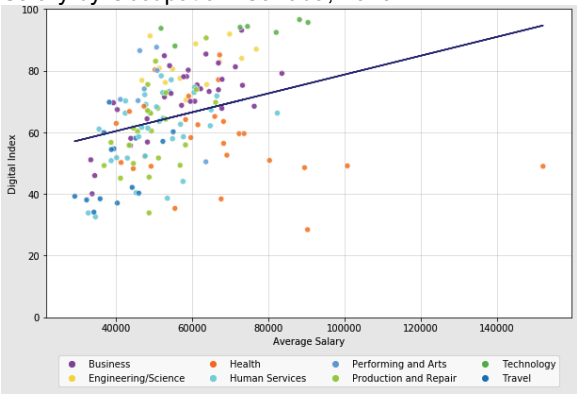
Figure 10: Correlation Between Digital Index and Remote Work: Canada, 2019



As the global pandemic continues, and digitalization progresses, it is important for the Canadian economy that workers be equipped with at minimum baseline digital skills which are portable across occupations and industries. This portability of skills allows workers to have more options available to them if they need to find new employment during all economic conditions.

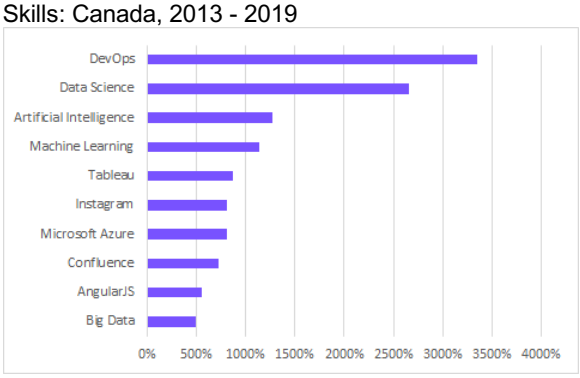
There is a positive relationship between income and digital index score in the Canadian economy is a positive one. Figure 11 depicts this relationship and underscores the speculation that workers in the least digital occupations have a high likelihood of being disproportionally affected by the COVID-19 pandemic. Not only are they the least likely to be able to work from home, but they are also the lowest earners and have likely few transferrable skills.

Figure 11: Digital Index and Minimum Advertised Salary by Occupation: Canada, 2019



The top 5 fastest growing digital skills in the Canadian economy between 2013 and 2019 have all seen very high growth rates. It is also interesting to note that all would be considered specialized skills. This suggests that the baseline skills are fairly constant, but the specialized skills, which rely on baseline for foundation, are the ones most rapidly changing.

Figure 12: Growth Rate of the Fastest Growing Digital Skills: Canada, 2013 - 2019



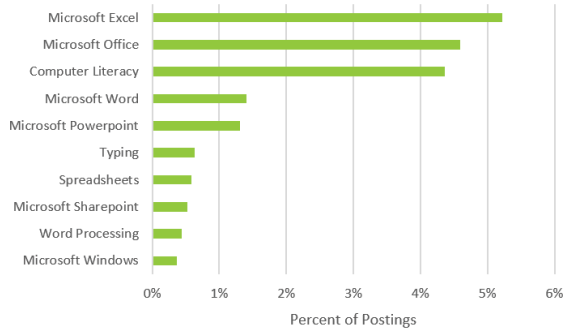
Workers in the Canadian economy are well suited for their next job, and the job after that if they are equipped with digital skills, no matter the occupation or industry, and this is especially true in the face of the global pandemic, where much work now needs to be done remotely – something the Canadian economy seemed wary of as late as 2019.

Australia:

The Australian economy is characterized by a middling to low relative rate of jobs that are in digital occupations when compared to the other economies.

Microsoft products such as Excel and PowerPoint, along with basic computer literacy and typing skills, are amongst the top digital baseline skills requested in the Australian economy. The Australian economy has a relatively lower rate of requests for digital baseline skills when compared to the other economies studied in this report.

Figure 13: Digital Baseline Skills in Highest Demand: Australia, 2019



The requirement of specialized skills follows the pattern observed in all economies in this report – with the top ten requested digital specialized skills appearing in 0.5-2.5 percent of postings. These specialized skills include SAP, SQL, Social Media, and many programming languages.

Looking at the digital index of all occupations over time, there is a clear negative relationship between

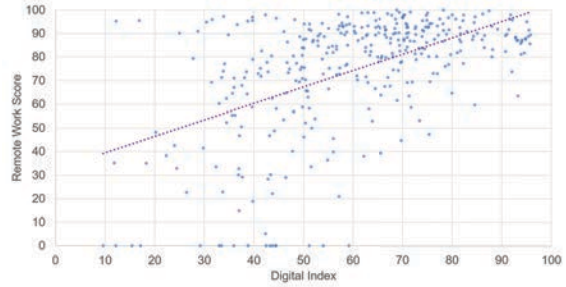
the digital index of an occupation in 2013 and the change in digital index for that occupation between 2013 and 2020. This suggests that even though the Australian economy is characterized by relatively low levels of digitalization, there is a pattern of increasing digital skill reliance, especially in the least digital occupations in 2013.

Figure 14: Correlation of Current Digital Index to Change Between 2013 and 2019: Australia

Australia's economy, while not the most digital of the economies studied in this report, does show indications that at minimum, some digital skills are required in most jobs. This suggests that workers acquiring digital skills for use in the Australian labor market may be more suitable for job openings across occupations, and therefore better chances of employment.

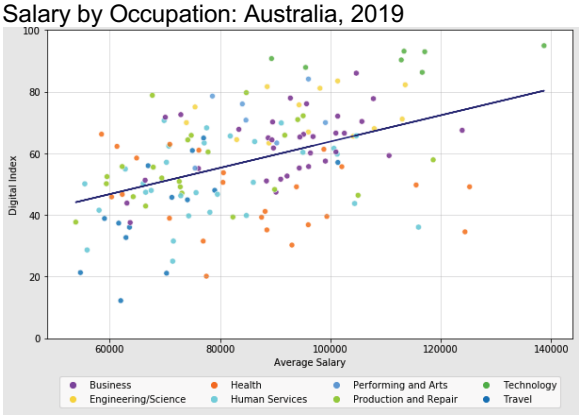
As we consider the impacts of the global COVID-19 pandemic, it is important to understand the availability of and attitude towards remote work prior to the onset of the virus. Australia finds itself relatively well positioned with high remote scores across all levels of digital indices, though this just means that remote work is listed as available, not that workers were actually working remotely in all of these positions.

Figure 15: Correlation Between Digital Index and Remote Work: Australia, 2019



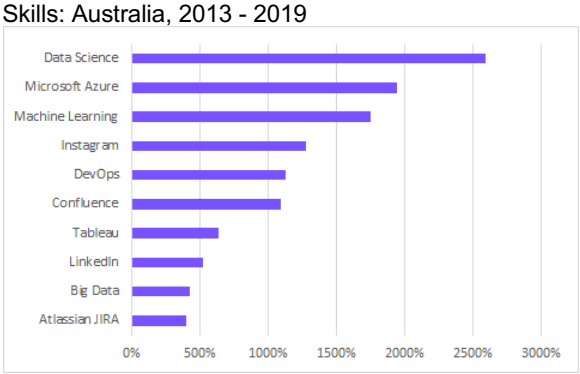
In the Australian economy, there is a strong positive relationship between an occupation's digital index score and the minimum advertised salary of that occupation. This is indicative of a premium being paid for digital skills that allow workers to perform in digital occupations.

Figure 16: Digital Index and Minimum Advertised Salary by Occupation: Australia, 2019



Digitalization happens at different speeds across economies, but the general trend is largely the same. In the Australian economy, the top ten fastest growing digital skills between 2013 and 2019 all experienced impressive growth rates, though somewhat lower than the top ten in the United States and Canadian economies.

Figure 17: Growth Rate of the Fastest Growing Digital Skills: Australia, 2013 - 2019



The fastest growing skills requested are a broad group consisting of software skills as well as general knowledge competencies, all of which would be considered specialized. Again, this does not mean to suggest that all workers need to be trained in these fast growing digital skills, but rather that they should be skilled in the underlying basic competencies that make learning specialized skills like those in figure 17 possible.

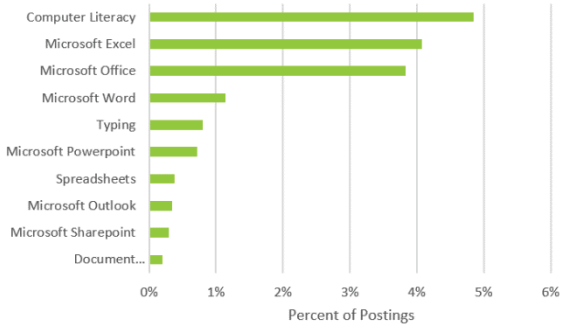
New Zealand:

The New Zealand economy is most similar to the Australian economy in a few respects, but generally it is quite different from the other economies studied. New Zealand finds itself with a much lower proportion of jobs in digital occupations, especially in low and middle skill occupations. In low skill positions in 2019, only 31% were in digital occupations, 48% of middle skill jobs were digital, and 80% of high skill jobs were

in digital occupations. All of these respective rates are the lowest of all economies in this report.

The digital skills, both baseline and specialized, that are most requested in New Zealand in 2019 are similar to those found in most other economies in this report. The notable difference is the rates at which they are requested. For baseline skills, most economies have the highest requested skill showing up in 10-13 percent of jobs, however in New Zealand the highest requested baseline digital skill appears in less than 6 percent.

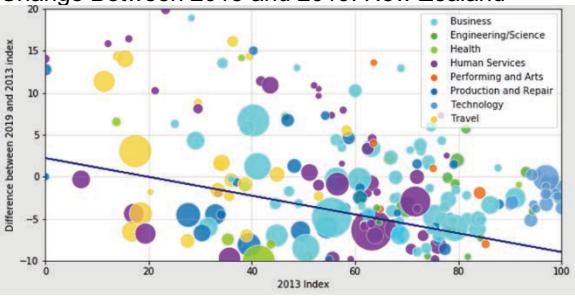
Figure 18: Digital Baseline Skills in Highest Demand: New Zealand, 2019



For digital specialized skills most economies see the highest requested skills reaching 2-3 percent of jobs. In New Zealand, the highest requested specialized skill is requested in less than 2 percent of jobs.

When examining the time trend of digital indices by occupation, New Zealand's economy behaves a bit differently than others examined in this report. Regardless of digital index in 2013 there has been minimal or even negative change in digital index scores between 2013 and 2019. This is suggestive that there has been little increase in digitalization, and in some cases regression in the trend.

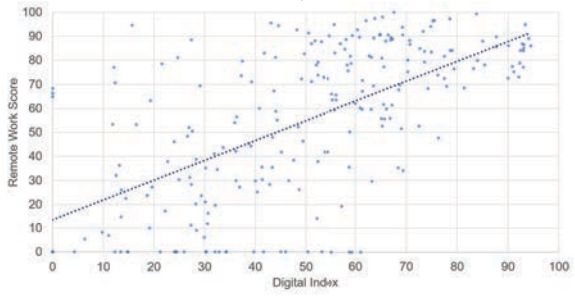
Figure 19: Correlation of Current Digital Index to Change Between 2013 and 2019: New Zealand



There may be something unique about New Zealand's economy that is causing digitalization to be much slower and less widespread than the other APEC economies examined in this report. It may be the industry composition or other related factors that drive this difference.

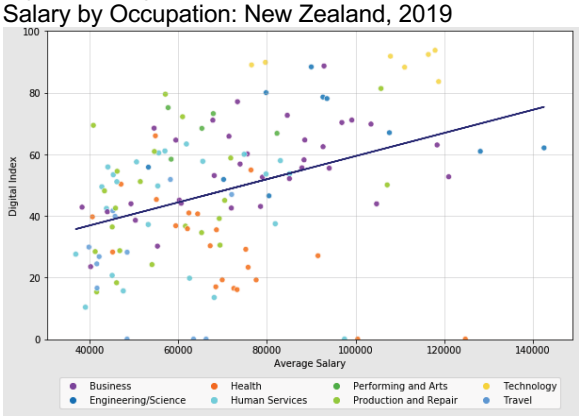
There is a strong relationship in the New Zealand economy between the digital index score in 2019 of an occupation and the remote work score of the occupation. New Zealand, like Australia, has a more positive relationship between remote work and digitalization than some other economies, though that does not mean that all of the workers who take the positions actually work remotely. This openness New Zealand economy may position New Zealand to be better equipped to weather the forced changes to work arrangements caused by the COVID-19 pandemic.

Figure 20: Correlation Between Digital Index and Remote Work: New Zealand, 2019



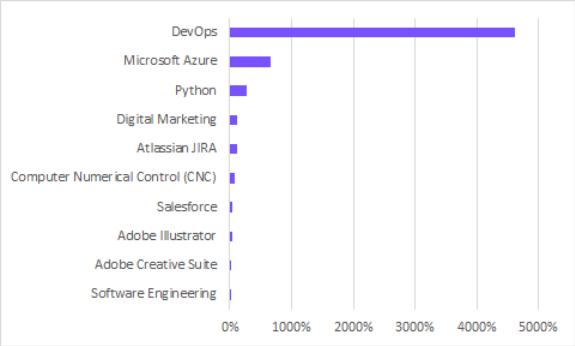
Though New Zealand is by some metrics less gripped by digitalization than other economies studied in this report, there is still likely a positive financial return to digital skills. This is evidenced by the relationship between an occupation's digital index and its minimum advertised salary as seen in figure 21.

Figure 21: Digital Index and Minimum Advertised Salary by Occupation: New Zealand, 2019



The top growth rates of digital skills in New Zealand, sans the top one or two skills, are magnitudes lower than their counterparts in the other economies studied. This is yet another piece of evidence that the New Zealand economy is experiencing digitalization in a different way than other economies.

Figure 22: Growth Rates of the Fastest Growing Digital Skills: New Zealand, 2013 - 2019



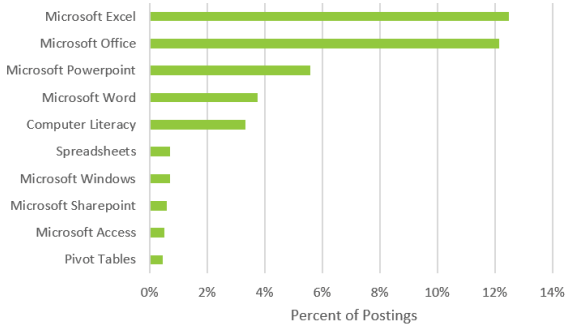
While the New Zealand economy experiences relatively less digitalization and lower growth, workers should still be equipped with digital skills. COVID-19 may increase the digitalization trend that has already taken a stronger hold in other economies, and with remote work already relatively well accepted, New Zealand might be in a prime spot to thrive.

Singapore:

The Singapore economy is in many regards the most digital of all economies examined in this report. Singapore has the highest digital scores by industry of any of the five economies except for the Professional, Scientific, and Technical Industry, where it places second to the Canadian economy by a small margin. Adding to the evidence that digitalization has taken a strong hold in Singapore we find that digitalization is strongly prevalent across skill levels.

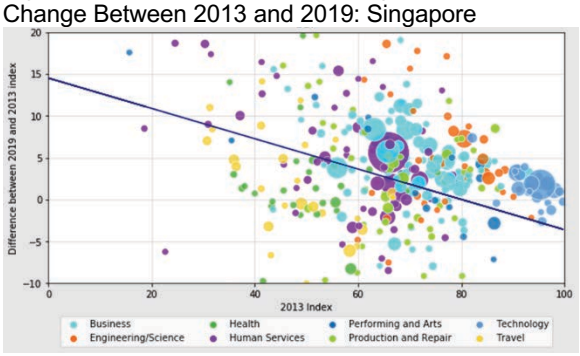
The top requested baseline digital skills in Singapore are similar to those in other economies examined. Like the economies of the United States and Canada, Singapore's highest baseline digital skills are requested in nearly 12 percent of all jobs, suggesting that they are in demand and highly transferrable.

Figure 23 Digital Baseline Skills in Highest Demand: Singapore, 2019



When examining the time trend of digital indices across occupations in Singapore, we see the greatest growth of any economy studied. The most growth is concentrated amongst the least digital occupations, where some experienced an increase of their digital index of 15 points or more. Among the occupation groups with the greatest increase in digital indices are Human Services and Production and Repair.

Figure 24: Correlation of Current Digital Index to Change Between 2013 and 2019: Singapore

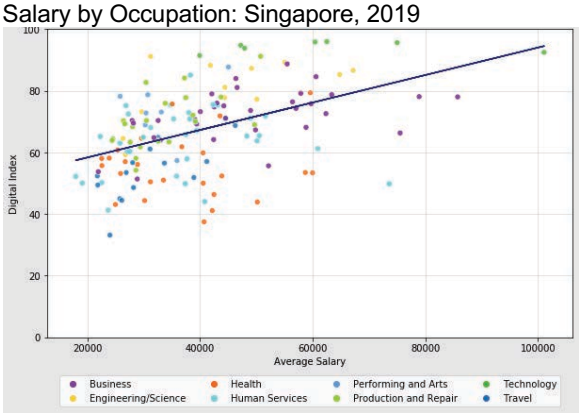


Also notable in the time trend analysis is that the most digital occupations are changing very little. This suggests that digitalization in these industries took place some time ago and has remained nearly constant ever since.

Unfortunately, there is no remote work data available for Singapore, so we are unable to examine the availability and acceptance of remote work in the Singapore economy prior to the outbreak of the COVID-19 pandemic. Without this data, we are unable to comment on the likely preparedness or lack thereof for COVDI-19 related remote work

Figure 25 shows that there is a positive relationship between an occupation's digital index score and the minimum advertised salary for that occupation.

Figure 25: Digital Index and Minimum Advertised Salary by Occupation: Singapore, 2019

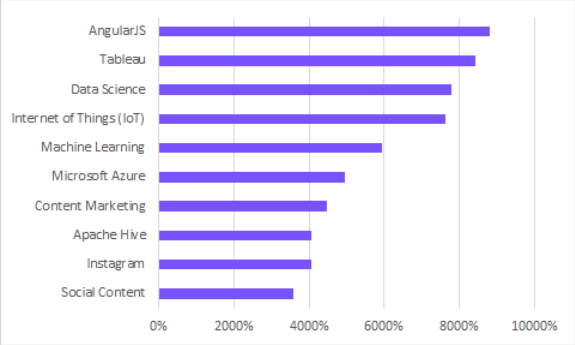


The positive relationship between an occupation's digital index and its minimum advertised salary suggests a positive return to digital skills, further underscoring the importance to having such skills.

To quantify the speed with which digitalization is changing the Singapore labor market, we can

examine the top 10 fastest growing digital skills between 2013 and 2019. In Singapore, these skills have grown a minimum of over 3000% -- outpacing the other economies in this report.

Figure 26: Fastest Growing Digital Skills: Singapore, 2013 - 2019



The Singapore economy is characterized by high rates of digitalization in all industries, which suggests a high rate of diffusion of digital skills. The Information industry is characterized by the highest digitalization index, though all industries examined were high compared to their counterparts. Also notable is the education industry, where the Singapore economy vastly outpaces all the rest. This may signify an effort to expose students to and prepare students for digital skill requirements of their future jobs. If this is in fact true, Singapore may be positioned well for the future.

Data and Methodology:

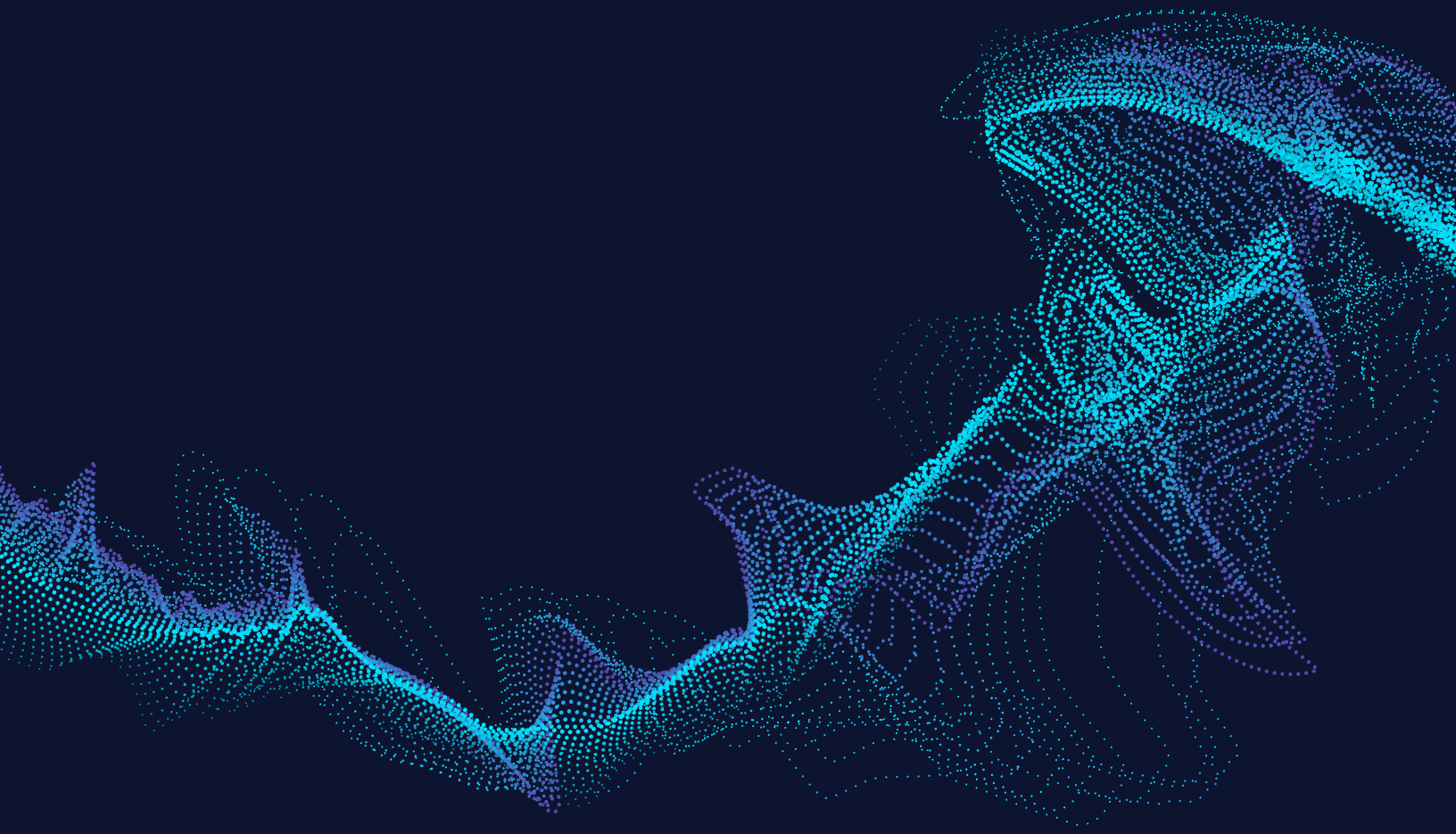
The indices and data analyses provided in this report are based on individual jobs rather than aggregate level occupation data. The benefit of this method is that it allows for a more detailed and critical analysis of the digital skills required of each industry and occupation studied. Using employer demand from job posting data rather than the skills of current employees to determine occupational skill demand is forward looking and potentially gives us a glimpse of future trends.

The job posting data used in this report is collected from a myriad of online posting sources and has been de-duplicated so that jobs that are for the same position but on different websites are not counted as multiple positions. While this data is rich in information, it is imperfect in two ways. First, there may be missing information, or even missing jobs. Not all jobs are posted online, and some jobs are posted to job boards that require login credentials or a membership to access them. Second, one posting may be utilized to fill multiple positions. In our data, we would only count this posting as a single opening, when it may be multiple. These limitations are unlikely to bias our findings, though, as the distribution of jobs in our data set largely mirrors the distribution of jobs in economy specific surveys.

One limitation of this type of methodology is that it does not consider differences across geographies within an economy, or differences across industries within an economy that employ a specific occupation – this level of granularity is beyond the scope of this research and would likely not be informative due to small sample sizes.[6] [7]

[6] O'Kane et al. "Digitalization in the German Labor Market." Bertelsmann Stiftung and Burning Glass Technologies, August 2020. https://www.bertelsmann-stiftung.de/en/publications/publication/did/digitalization-in-the-german-labor-market-en

[7] Muro, Mark, Sifan Liu, Jacob Whiton, and Siddharth Kulkarni. "Digitalization and The American Workforce." Brookings, November 2017. https://www.brookings.edu/wp-content/uploads/2017/11/mpp_2017nov15_digitalization_full_report.pdf



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