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Impact of AI on Singapore's Labor Market

Singapore

Shujaat Khan

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Impact of AI on Singapore's Labor Market

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August 2024

ABSTRACT: Singapore is well-prepared for AI adoption but stands highly exposed to the increasing use of artificial intelligence (AI) technologies in the workplace, due to a large share of skilled workforce. While half of the highly exposed segment of the labor force stands to benefit from the appropriate use of AI to complement their tasks, potentially boosting their productivity, the other half may face greater vulnerability to AI's disruptive effects due to lower levels of AI complementarity. Estimates suggest that women and younger workers are more exposed to the effects of AI, which, in the absence of appropriate policies, could worsen income inequality in Singapore. Targeted training policies, leveraging on the existing SkillsFuture program, can harness AI's potential. Additionally, focused upskilling can mitigate the disruptive impact of AI on vulnerable workers.

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Singapore

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IMPACT OF AI ON SINGAPORE'S LABOR MARKET

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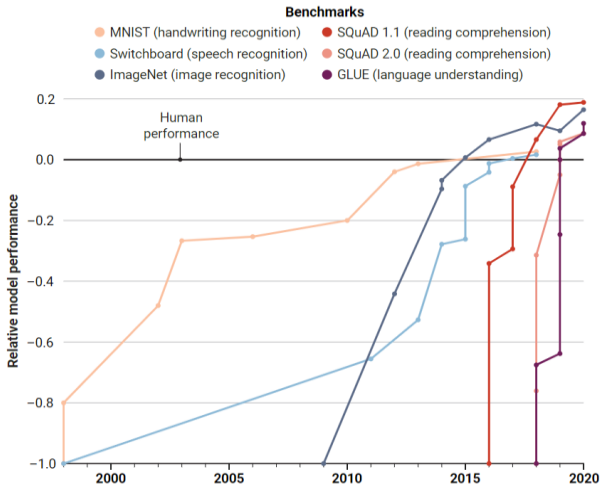
A. Introduction

1. Artificial intelligence (AI) has been rapidly advancing in its abilities to conduct human tasks. In recent years, the pace of development in AI technologies has been remarkable (Figure 1). This progression is evident in the increasing sophistication of AI systems, which are now able to undertake a wide array of activities, ranging from simple data entry to complex text comprehension and problem solving. As these technologies evolve, they are increasingly mimicking human intelligence and behaviors, thereby blurring the lines between human and machine capabilities. This shift is transforming various industries, as AI applications become more prevalent and adept at executing tasks that were once considered exclusively within the purview of human expertise.

Figure 1. Singapore: AI's Abilities to Conduct Human Tasks Have Increased Rapidly in Recent Year



Source : https://www.science.org/content/article/computers-ace-iq-tests-still-make-dumb-mistakes-can-different-tests-help

2. Singapore is well-prepared for AI adoption. The IMF's AI Preparedness Index (AIPI) evaluates AI readiness in 174 countries using a comprehensive set of macro-structural indicators, including digital infrastructure, human capital and labor market policies, innovation and economic integration, and regulation and ethics.[1] Singapore excels across all these indicators, underscoring its strong readiness for AI integration. This reflects Singapore's investment in robust digital infrastructure, which ensures seamless connectivity and supports advanced AI technologies.

[1] See https://www.imf.org/external/datamapper/datasets/AIPI.

3. AI technologies are expected to change the way we work, which will have implications for labor markets around the world. As AI proliferates the workspace, it brings with it the potential for increased productivity and efficiency, but it also raises concerns about the displacement of workers whose tasks can be automated with limited human intervention. This dual-edged nature of AI's integration into the workforce necessitates a careful examination of its impact on labor markets, balancing the benefits of enhanced productivity against the risks associated with job losses and the need for workforce adaptation. Furthermore, the impact of AI on the workforce is likely to vary across different demographics, influenced by the extent to which various occupations are exposed to AI integration and how these occupations are distributed among different genders and age groups. Therefore, tailoring policy responses to harness the benefits of AI while mitigating the adverse effects that could lead to increased income and wealth inequality is crucial to ensuring equitable outcomes across all segments of society.

4. This study utilizes estimates of AI exposure and complementarity to study the impact of AI on Singapore's labor market. Following Felten et al. (2021), we make use of a micro approach that links AI's applications to the workplace abilities required in different occupations to estimate each occupation's exposure to AI (Section B), which reflects the potential for AI to be integrated into that occupation. To allow for a distinction to be made between occupations for which AI has the potential to complement or to reduce the demand for labor, we also use estimates of potential AI complementarity for various occupations from Pizzinelli et al. (2023). Detailed labor force data is used to estimate occupation-level exposure to AI in Singapore (Section C) and to examine how the exposure differs among various demographic groups (Section D). Policies that harness the benefits of AI, while mitigating its adverse effects, are also discussed (Section E).

B. Measuring Occupational Exposure to AI

5. A micro approach that links applications of AI to workplace abilities can be used to study the occupational exposure to, or potential for integration of, AI. AI exposure for a particular occupation measures the extent to which AI has a potential to be integrated in the occupation. This study relies on estimates of occupational exposure to AI produced by Felten et al. (2021) that links 10 common applications of AI (for example, abstract strategy games, image recognition, speech recognition)[2] to a range of workplace abilities and occupations. A total of 52 workplace abilities (covering cognitive, physical, psychomotor, and sensory abilities) are considered. O*NET, a database developed by the US Department of Labor, uses these abilities to define every occupation (up to 8-digit level based on the Standard Occupational Classification (SOC) system) based on the workplace activities of each occupation. Using survey responses from gig workers on Amazon's Mechanical Turk (mTurk) platform, Felten et al. (2021) link each AI application to various workplace abilities based on whether the respondents believe that the application is related to or could be used for each workplace ability. If we define x_{ij} as the relatedness score of AI application $i \in \{1, \ldots, 10\}$ and occupational abilities $j \in \{1, \ldots, 52\}$, then the ability-level AI exposure is given by $A_j = \sum_{i=1}^{10} x_{ij}$. This ability-level AI exposure, combined with weights for the prevalence and

[2] The 10 AI applications considered by Felten et al. (2021) are: abstract strategy games; real-time video games; image recognition; visual question answering; image generation; reading comprehension; language modeling; translation; speech recognition; and instrumental track recognition.

importance of the abilities in each occupation, which are also available in O*NET's description of occupations, is used to calculate the exposure of each occupation to AI. This is referred to as AI occupational exposure (AIOE).

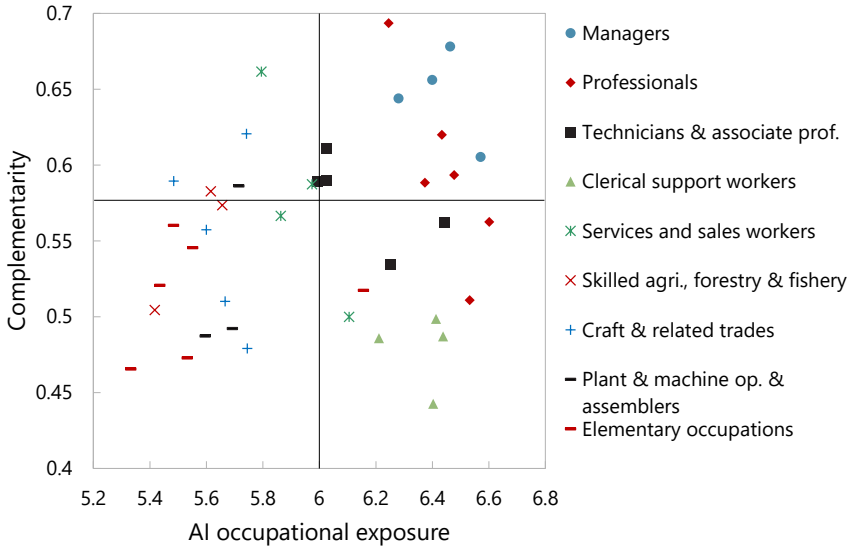
6. In addition to understanding exposure to AI, it is also important to evaluate whether AI might augment worker capabilities or diminish labor demand. AI complementarity for a particular occupation measures the extent to which AI can complement human labor in the occupation. We use estimates of AI complementarity from Pizzinelli et al. (2023), which utilizes data related to work contexts and skills of occupations from the O*NET database. Work contexts encompass both the social and physical dimensions of performing tasks within specific occupations. Factors such as the significance of decision-making and the severe implications of mistakes are job characteristics that could prompt the insistence on human oversight for final judgments or interventions. Pizzinelli et al. (2023) use case-by-case assessments to argue that certain contexts might deter societies from allowing unsupervised autonomous use of AI. Skills, on the other hand, are defined by the level of education, on-the-job training, and professional experience needed to perform a job. The consideration of skills stems from the notion that jobs demanding more extensive professional development are better positioned to incorporate AI knowledge into their training, thereby preparing workers with skills that complement AI.

7. Taken together, occupational exposure to and complementarity with AI offer deeper insights on the potential impact of AI on different jobs. We define an occupation as having high (low) AI exposure or complementarity if it has an AI exposure or AI complementarity score above (below) the median for all occupations. Estimates of AIOE reveal a complex and varied landscape across different occupations (Figure 2). While the workers in the high-exposure and high-complementarity occupations are expected to witness gain in productivity from the appropriate use and integration of AI, the workers in high-exposure and low-complementarity occupations are at a greater risk of being displaced by AI. AI complementarity is less relevant for occupations with a low AI exposure; therefore, the focus of this work is on occupations that have a high level of exposure. Based on these estimates, at the aggregate (1-digit) level, high-skilled occupations, such as managers, professionals, and technicians and associate professional, tend to have a higher exposure to AI (that is, the AIOE score is greater than the median AIOE score). In contrast, low-skilled occupations, such as elementary occupations, plant and machine operators and assemblers, craft and related trade workers, and skilled agriculture, forestry and fishery workers tend to have a lower exposure to AI. Semi-skilled roles such as clerical support workers are estimated to be highly exposed to AI, whereas services and sales workers demonstrate a mix of high and low AI exposure, depending on the specific job within that group.

8. There is significant variation of AI complementarity both across and within occupational categories. While at the aggregate (1-digit) level, generally, the sub-occupations (2-digit level) are within the same AI exposure classification (high vs. low), there is significant variation within each major occupation based on the level of complementarity of AI in those roles. For instance, professionals tend to have a high exposure to AI; however, some jobs within this category exhibit high complementarity (for example, health professionals) and others exhibit low complementarity (for example, information and communication technology professionals). Nonetheless, there are also high-exposure occupations that are either entirely (at the 2-digit level) in

the high-complementarity classification (managers) or are entirely in the low-complementarity classification (clerical support workers, elementary occupations). Workers in managerial roles, who typically have high skill-level and greater experience, benefit from the higher degree of complementarity, while workers in clerical support positions, such as general and keyboard clerks and customer service clerks, are in roles that offer a lower degree of complementarity. Since elementary occupations, and plant and machine operators and assemblers, craft and related trade workers, and skilled agriculture, forestry and fishery workers have low exposures to AI, the level or variation in complementarity is less important in determining the impact of AI for workers in these occupations.

Figure 2. Singapore: AI Exposure and Complementarity at 2-Digit Occupational Level



Source: Felten et al. (2021), Pizzinelli et al. (2023), and IMF staff calculations.

C. AI Exposure in Singapore's Labor Market

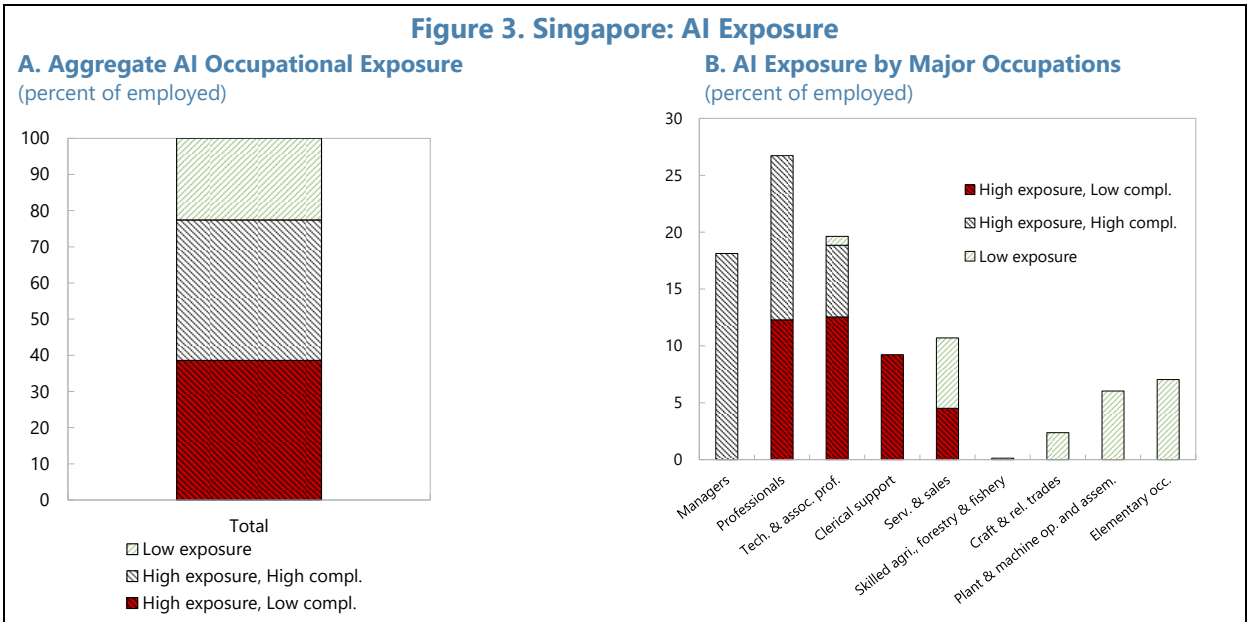
9. Singapore's labor market is highly exposed to AI, driven largely by the concentration of high- and semi-skilled workers in its workforce. Estimates, based on Singapore's 2022 labor force survey of resident workers, show that about 77 percent of Singapore's employed workers are highly exposed to AI (Figure 3A), that is, a significantly large share of workers are working in occupations that have a high potential for AI to integrate into their occupations. This exposure not only surpasses the average high exposure rates of 40 percent for emerging market economies (EMs) and 26 percent for low-income countries (LICs), as estimated by Cazzaniga et al. (2024), but also exceeds the AI exposure rate of 60 percent estimated for advanced economies.[3] Singapore's high AI exposure largely stems from a minimal portion (about 23 percent of employed) of its workforce being employed in low-skilled jobs—in contrast to the larger shares seen in emerging markets (EMs)

[3] Note that the exposure estimates for Singapore are based on labor force data covering only resident workers.

and low-income countries (LICs)—coupled with a substantially larger proportion of individuals working in high- and semi-skilled roles.

10. Within occupations highly exposed to AI, there is an equal distribution of workers between roles that exhibit high and low complementarity with AI. Of those workers who are highly exposed to AI, roughly half (38.9 percent of employed) are in occupation with high AI complementarity and the other half (38.6 percent of employed) have jobs with low AI complementarity. The former mainly comprise managers, science and engineering, health, and legal professionals and associate professionals, and teaching professionals. These workers stand to gain in productivity, provided they have access to the required infrastructure and possess the necessary skills to interact with AI technologies effectively. In contrast, business and administration, and information and communications technology professionals and associated professionals, clerical support workers, and a fraction of services and sales workers are at a higher risk of substitution due to AI's abilities to mimic or automate the tasks required in those jobs.

Figure 3. Singapore: AI Exposure



Source: IMF staff calculations based on Singapore's 2022 labor force survey.

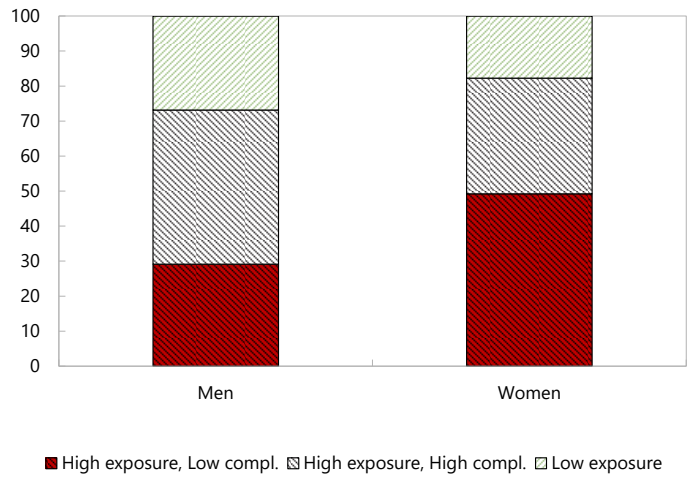
D. Demographic Implications

11. Our results suggest that female workers in Singapore have a higher exposure to AI with relatively low AI complementarity. Estimates suggest that a larger fraction of female workers are exposed to AI, particularly in occupations which have low complementarity with AI (Figure 4). About 49 percent of female workers are employed in occupations that have a high exposure and low complementarity with AI, compared to 29 percent of male workers falling in the same category. These differences largely stem from a larger share of female workers employed in clerical support roles (15 percent, relative to men's 4 percent employment share) and a larger share of women employed as business and administration associate professionals (14 percent, relative to men's 9 percent employment share) and sales workers (6 percent, relative to men's 3 percent employment

share), all of which have a high exposure to and low complementarity with AI. In addition, a significantly higher share of men is employed in high exposure occupations that also have a high complementarity with AI (44 percent, relative to women's 33 percent employment share). This is driven by the greater share of men employed as managers (20 percent, relative to women's 16 percent) and science and engineering associate professionals (7 percent, relative to women's 2 percent employment share), occupations which stand to benefit from increased productivity due to AI augmentation. These differences have the potential for widening gender gaps with a widespread adoption of AI technologies in work.

12. Younger Singaporean workers are employed in occupations with a higher susceptibility to displacement due to AI. Although the occupational employment data by age in this study only permit a broad differentiation between age categories, they still enable us to draw some valuable inferences. About 6 percent of the workers are between 15 to 24 years old and the remaining workers are 25 years and older. Estimates suggest that half of the younger workers are employed in occupations with high AI exposure and low AI complementarity and only one-fifth of the young workers are employed in occupations with high AI exposure and high AI complementarity (Figure 6). A higher percentage of younger workers are found in clerical support positions and sales jobs compared to their older counterparts. Moreover, a smaller proportion of young workers occupy roles likely to gain from AI augmentation, like managerial and certain professional positions, which generally demand higher skills and experience accumulated over more extended periods. While these findings suggest that female and younger Singaporean workers are more likely to be in occupations with high AI exposure and low AI complementarity, it is also important to note that emerging research (Noy and Zhang, 2023; Peng et al., 2023; Brynjolfsson et al., 2023) indicates that generative AI may also complement inexperienced and lower-skilled workers in routine jobs such as writing, coding, and call center operations. These studies suggest that AI technologies might mitigate some displacement risks by enhancing worker productivity and capabilities in these roles. Additionally, the broad age categories used in this study limit the applicability of this analysis to a small share of young workers between 15 to 24 years old, who are typically students in casual or part-time jobs. Consequently, younger workers in prime-age full-time roles may experience different impacts from AI.

Figure 4. Singapore: AI Exposure by Gender

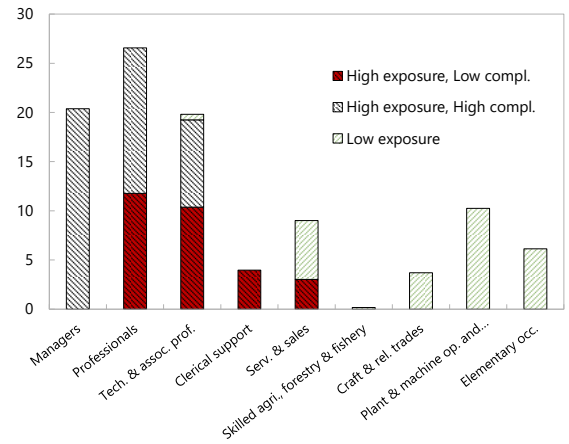


Source: IMF staff calculations based on Singapore's 2022 labor force survey.

Figure 5. Singapore: Detailed AI Exposure by Gender

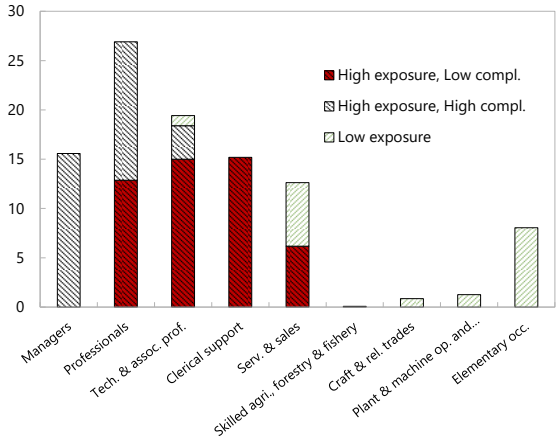
A. AI Exposure for Men

(percent of employed)



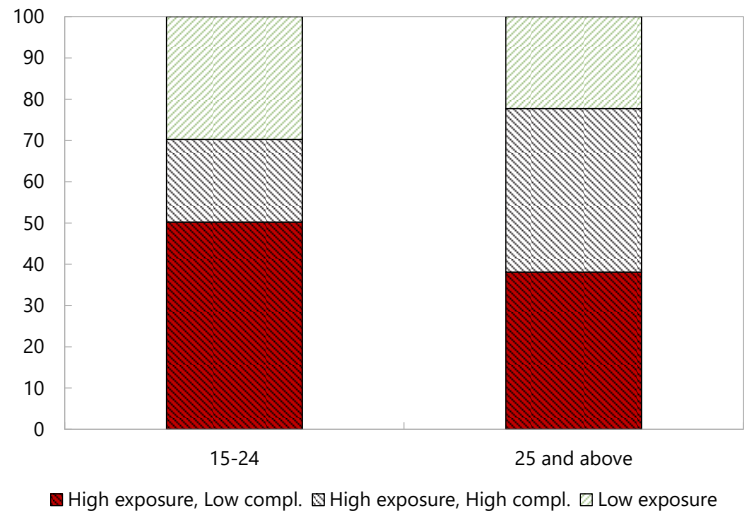
B. AI Exposure for Women

(percent of employed)



Source: IMF staff calculations based on Singapore's 2022 labor force survey.

Figure 6. Singapore: AI Exposure by Age

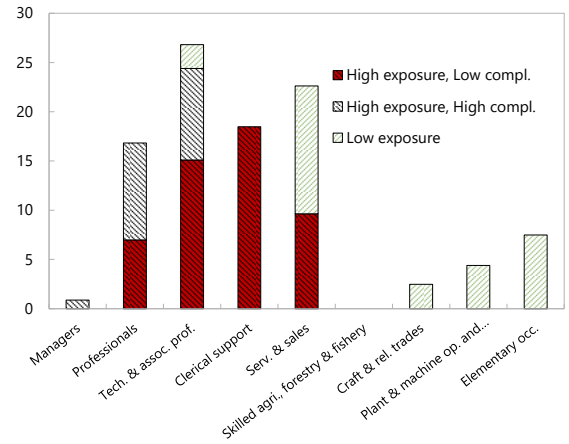


Source: IMF staff calculations based on Singapore's 2022 labor force survey.

Figure 7. Singapore: Detailed AI Exposure by Age

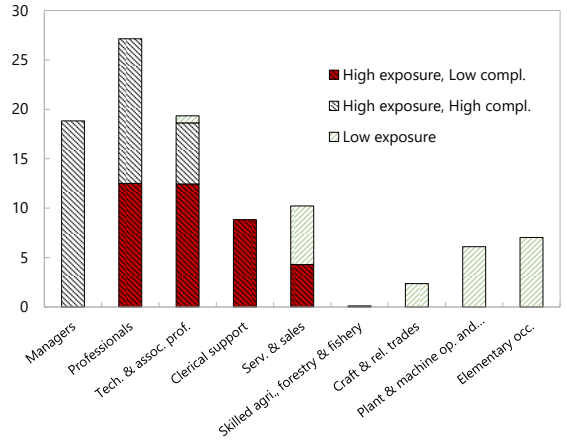
A. AI Exposure for 15-24 Year Olds

(percent of employed)



B. AI Exposure for 25 Years and Older

(percent of employed)



Source: IMF staff calculations based on Singapore's 2022 labor force survey.

E. Policies

13. AI technologies offer the potential to boost productivity across sectors, but realizing these benefits requires the implementation of appropriate policies. As industries adapt to the rapid advancements in AI, policies focused on education and workforce training can equip individuals with the necessary skills to thrive in an AI-enhanced economy. Such re-skilling and upskilling programs are important even for workers in occupations that have high complementarity with AI, because high complementarity does not automatically imply that workers in those

occupations will see productivity increases or are immune to AI-induced displacement. For these workers to truly benefit from AI, relevant training and skills development are essential. In this regard, Singapore has existing frameworks, such as the *SkillsFuture* program and Career Conversion Programmes (CCPs), that provide training geared towards AI technologies and can be further enhanced. The analysis above highlights that a significant share of Singapore's workforce, particularly managers, science and engineering professionals and associate professionals, health and legal experts, and educators, could see productivity gains from AI, provided they receive the right training. Initiatives to raise awareness of the impact of key technologies such as AI on jobs and skills through Jobs Transformation Maps, along with efforts to encourage the adoption of AI to transform existing operations and processes, will position Singapore to better leverage the opportunities presented by AI. Furthermore, the government and the private sector can collaborate to identify emerging skills gaps and develop targeted training programs. By fostering a culture of continuous learning and innovation—which are also policy objectives set in the *Forward Singapore* initiative—Singapore can ensure its workforce remains competitive and adaptable in the face of technological change, setting a global standard for AI integration into the workforce.

14. Policies can also mitigate the disruptive impact of AI. Our analysis indicates that many in Singapore's workforce are in jobs with low AI complementarity, increasing their risk of being replaced by AI. This risk is particularly acute for those in clerical support, business and administration, and sales roles, making upskilling and reskilling programs critical for facilitating their transition to new employment opportunities. The planned introduction of a scheme offering temporary support for the involuntarily unemployed can mitigate the potential disruptive impact of AI on such workers. While the recently launched *SkillsFuture* Level-Up Program offers promising support, it predominantly targets mid-career individuals. Given our findings, expanding such initiative to include younger workers, who are at higher risk of displacement by AI advancements, can mitigate the impact of AI. Furthermore, incorporating AI literacy and digital skills training into the education system can proactively prepare future generations for the evolving job market, ensuring long-term resilience against the challenges posed by AI. Singapore's strong emphasis on human capital development, exemplified by initiatives like the National Digital Literacy Programme to improve digital literacy, equips its workforce with the necessary skills to thrive in an AI-driven economy.

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