



Report skills and tasks

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Abstract

We analyse the evolution of skill supply and routine task intensity (RTI) across 16 high-income countries using harmonised worker-level data from two cycles of the OECD Programme for the International Assessment of Adult Competencies (PIAAC, 2011–2023). Combining direct measures of adult skills with task-based indicators, we document a broad decline in the routine content of work across countries. This decline is driven primarily by changes in task composition within occupations rather than by shifts in occupational structure. While routine intensity remains systematically higher among women than men, the gender gap narrows over time, reflecting uneven but gradual reallocation of tasks across demographic groups. Taken together, the results highlight that digital transformation reshapes labour demand mainly through within-job task adjustments, with important implications for skill development, gender equality, and policies aimed at supporting workforce adaptability.

1. Introduction

We investigate the evolution of skill supply, measured by workers' literacy, numeracy, and problem-solving skills, and the routine intensity of tasks performed at work (RTI) across 16 high-income countries. RTI captures the task content of jobs and thus reflects the skills effectively demanded and utilised in the labour market, allowing us to assess how digital and green transformations are reshaping skill demand. Analysing these developments is a necessary first step for assessing potential skill shortages and mismatches that may arise during digital and green transformations, as imbalances emerge when workers' observed skills diverge from the tasks and skills effectively demanded in the labour market.

We analyse the changes in skill supply and RTI using harmonised worker-level data from two waves of the OECD Programme for the International Assessment of Adult Competencies (PIAAC), collected between 2011–2023 in 16 high-income countries. The PIAAC dataset allows for constructing comparable task-based indicators and linking them to detailed measures of workers' education, literacy proficiency, and demographic characteristics. This approach provides a comprehensive picture of how the task content of jobs is evolving and whether these changes differ across population groups, occupations, and countries.

Our results show a broad decline in routine work across countries, driven mainly by within-occupation adjustments rather than shifts in employment structure. However, technologies differ in their effects: some reduce routine intensity, while others reinforce it. Human capital remains a strong predictor of task content, and gender differences in RTI persist, although they narrow over time. These findings underline that technological change reshapes tasks unevenly, depending on the specific functions of adopted technologies and the skill composition of the workforce.

2. Data and measurement

The worker-level dataset used in this study encompasses 16 high-income countries and is derived from two cycles of the OECD's Programme for the International Assessment of Adult Competencies – PIAAC. The sample sizes comprise several thousand working individuals aged 16–65 years old.

Selecting countries for the analysis, we restrict the sample to those participating in both waves of the PIAAC survey. Several countries were excluded because they were covered in only a single wave—for example, Switzerland, Croatia, Latvia, and Portugal—which prevents the construction of a harmonised

two-wave dataset. In addition, the analysis requires access to a core set of individual-level variables, including age, education, and occupation. Not all countries in the second PIAAC cycle make these variables publicly available. In such cases, access must be requested from the national statistical office or the institution responsible for implementing PIAAC in cooperation with the OECD. However, some countries do not provide these data to external researchers. In our case, Canada and New Zealand explicitly denied access. At the same time, the Scandinavian countries (Denmark, Norway, Sweden, and Finland) as well as Estonia allow access to second-cycle data only through country-specific secure research environments linked to population registers, which makes their data effectively incompatible with cross-country PIAAC analysis. Moreover, Lithuania and the United Kingdom did not respond to our requests for data access. As a result, the final sample is limited to countries for which harmonised data from both PIAAC waves, including essential background variables, are available.

The final sample consists of the following countries: Austria, Belgium, Chile, the Czech Republic, France, Germany, Hungary, Israel, Italy, Japan, South Korea, Poland, Singapore, Slovakia, Spain, and the United States. For 12 out of 16 countries studied here, the first cycle PIAAC data were collected in 2011-2012 (Austria, Belgium, Czech Republic, France, Germany, Japan, Italy, Poland, South Korea, Slovakia, Spain, the US), for three in 2014-2015 (Chile, Israel, Singapore), and for one in 2017-2018 (Hungary). The data for the second cycle of PIAAC were collected in 2022-2023.

We interpret PIAAC test scores in literacy, numeracy, and problem solving as measures of workers' skill supply, capturing their underlying cognitive competencies rather than formal qualifications. However, when comparing results over time, only literacy and numeracy can be directly compared between the first and second PIAAC cycles, as their measurement frameworks and scales remain consistent. This is not the case for problem solving, which in the second cycle focuses on adaptive problem solving—the ability to respond to changing contexts and demands by integrating knowledge, reasoning, and technology use—rather than on problem solving in technology-rich environments, as in the first cycle.

It is important to note, however, that several major European countries—such as France, Italy, and Spain—did not administer the problem-solving assessment, which limits the cross-country coverage of these indicators. Interpreted within each cycle, the available measures nonetheless provide valuable insight into the distribution of workers able to perform complex, ICT-related tasks. Routine Task Intensity (RTI) captures the routine content of tasks performed in workers' jobs and is interpreted as a measure of the task demands that are effectively utilised in the labour market, conditional on available skills and technologies.

Following Lewandowski et al. (2022), we create a worker-level task measure of routine task intensity in the spirit of Acemoglu and Autor (2011). We omit farmers and skilled agricultural workers (ISCO 6) from the sample. For methodological details, see Lewandowski et al. (2022). We calculate the worker-level routine task intensity according to the following formula:

$$RTI = \ln(r_{cog}) - \frac{(nr_{analytical} + nr_{personal})}{2} \quad (1)$$

where, r_{cog} , $nr_{analytical}$, $nr_{personal}$ are routine cognitive, non-routine cognitive analytical, and non-routine cognitive personal task levels. Particular task measures and RTI are standardised using their mean and standard deviation in the United States in the first cycle of PIAAC.

3. Descriptive evidence

3.1. Skill supply

The OECD Programme for the International Assessment of Adult Competencies (PIAAC) measures key information-processing skills—literacy, numeracy, and problem solving in technology-rich environments—among adults aged 16 to 65. The study provides internationally comparable data on the proficiency of the working-age population, offering insights into how well adults can understand, use, and engage with written and numerical information in everyday life and at work. As such, PIAAC results serve as a useful proxy for the general skill supply in an economy, reflecting the human capital available to support productivity and innovation.

Figure 1 presents average literacy and numeracy test scores from the OECD PIAAC study, comparing results from the first (2011–2017) and second (2022–2023) cycles across age groups and countries. In general, both literacy and numeracy scores tend to decline over time. For literacy, increases are observed only in Belgium and Germany, where most age groups show higher scores in the second cycle, while in other countries literacy levels are lower than in the first cycle. In contrast, improvements in numeracy are more frequent: Chile, France, Japan, and Singapore record higher scores in most age groups, and Germany shows increases across all groups. In Belgium and Spain, three age groups report higher numeracy, while decreases dominate in the remaining countries. Notably, in Belgium, both literacy and numeracy scores declined among the youngest respondents (aged 24 and less).

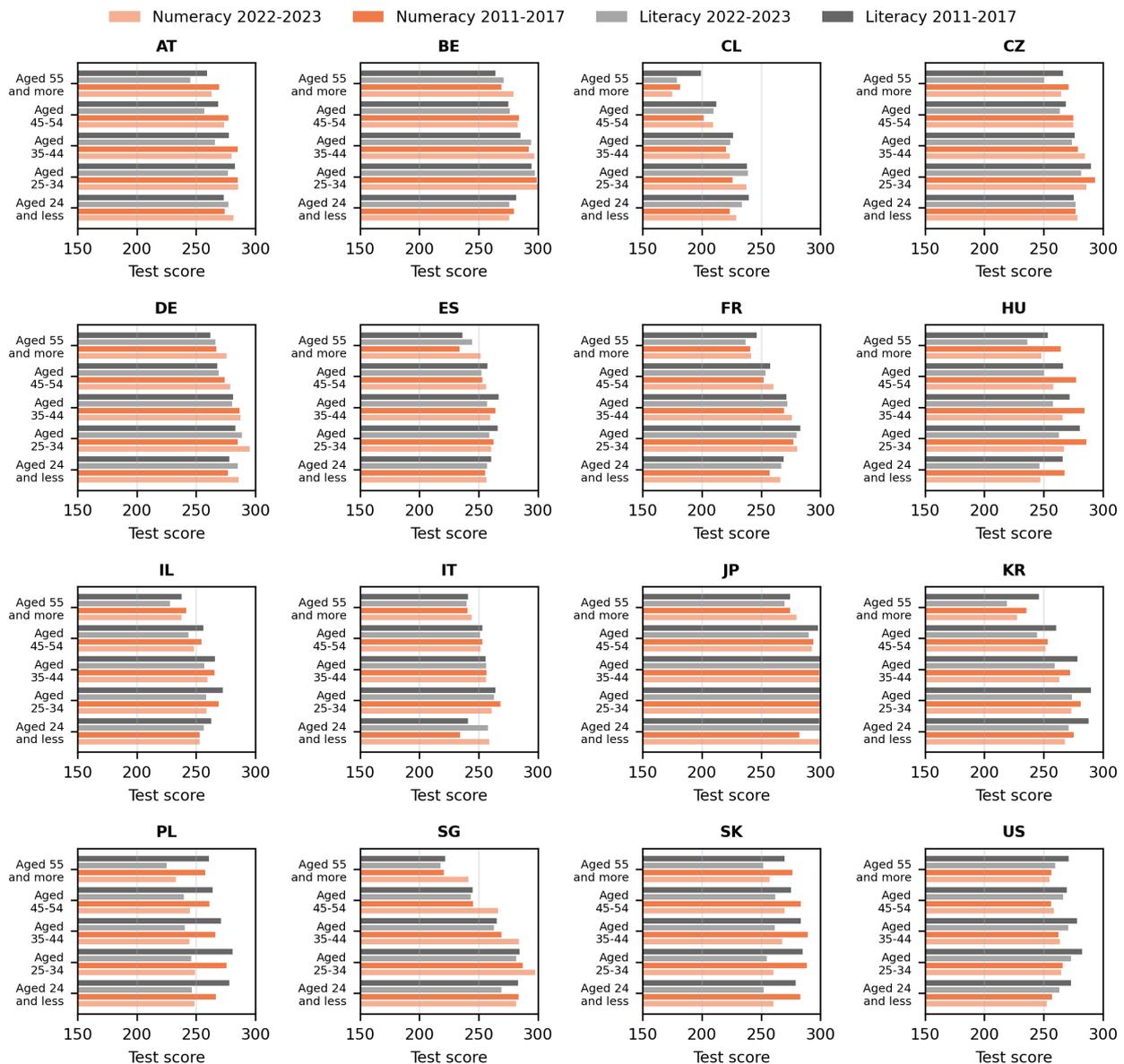
In the first PIAAC cycle, the highest literacy scores were found in Japan, Belgium, Slovakia, the Czech Republic, and the United States, while the highest numeracy scores were recorded in Japan, Belgium, Slovakia, the Czech Republic, and Austria. Countries with the lowest literacy performance included

Chile, Italy, Singapore, Spain, and Israel, and the lowest numeracy scores were observed in Chile, Italy, Spain, Israel, and the United States. In the second cycle, Japan, Belgium, Germany, the Czech Republic, and the United States achieved the highest literacy results, whereas Japan, Belgium, Germany, the Czech Republic, and Austria led in numeracy. The lowest literacy scores in the second cycle were observed in Chile, Poland, South Korea, Israel, and Hungary, and the lowest numeracy results in Chile, Poland, Israel, Italy, and South Korea.

It is important to note that the cross-country comparison includes only those countries that participated in both PIAAC cycles, so the analysis does not cover the full list of participating countries.

Next, we examine gender differences in literacy and numeracy scores (Figure 2). Overall, the patterns are similar to those observed by age groups. For literacy, score increases are visible only in Belgium and among women in Germany, while in all other countries literacy proficiency declined for both sexes between the two PIAAC cycles. For numeracy, improvements are more widespread: both men and women show higher scores in Belgium, Chile, France, Japan, and Singapore. In addition, numeracy increased among men in the United States and among women in Spain and Italy, whereas in the remaining countries scores fell for both genders.

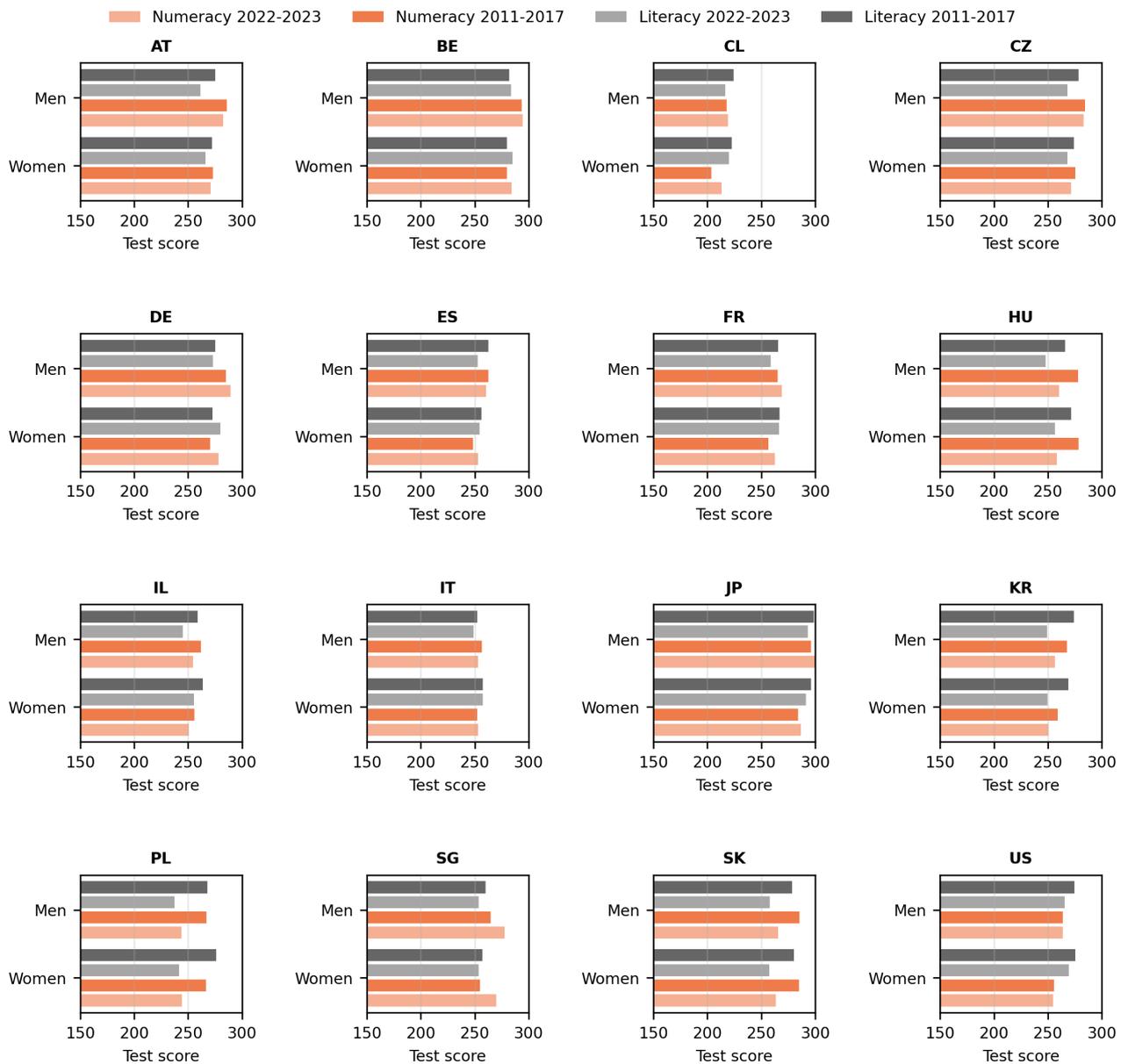
Figure 1 Literacy and numeracy test scores for the first and second PIAAC cycle, by age group and country



Source: Own calculations based on PIAAC data. For 12 out of 16 countries studied here, the first cycle PIAAC data were collected in 2011-2012 (AT, BE, CZ, DE, ES, FR, JP, IT, KR, PL, SK, US), for three in 2014-2015 (CL, IL, SG), and for one in 2017-2018 (HU).

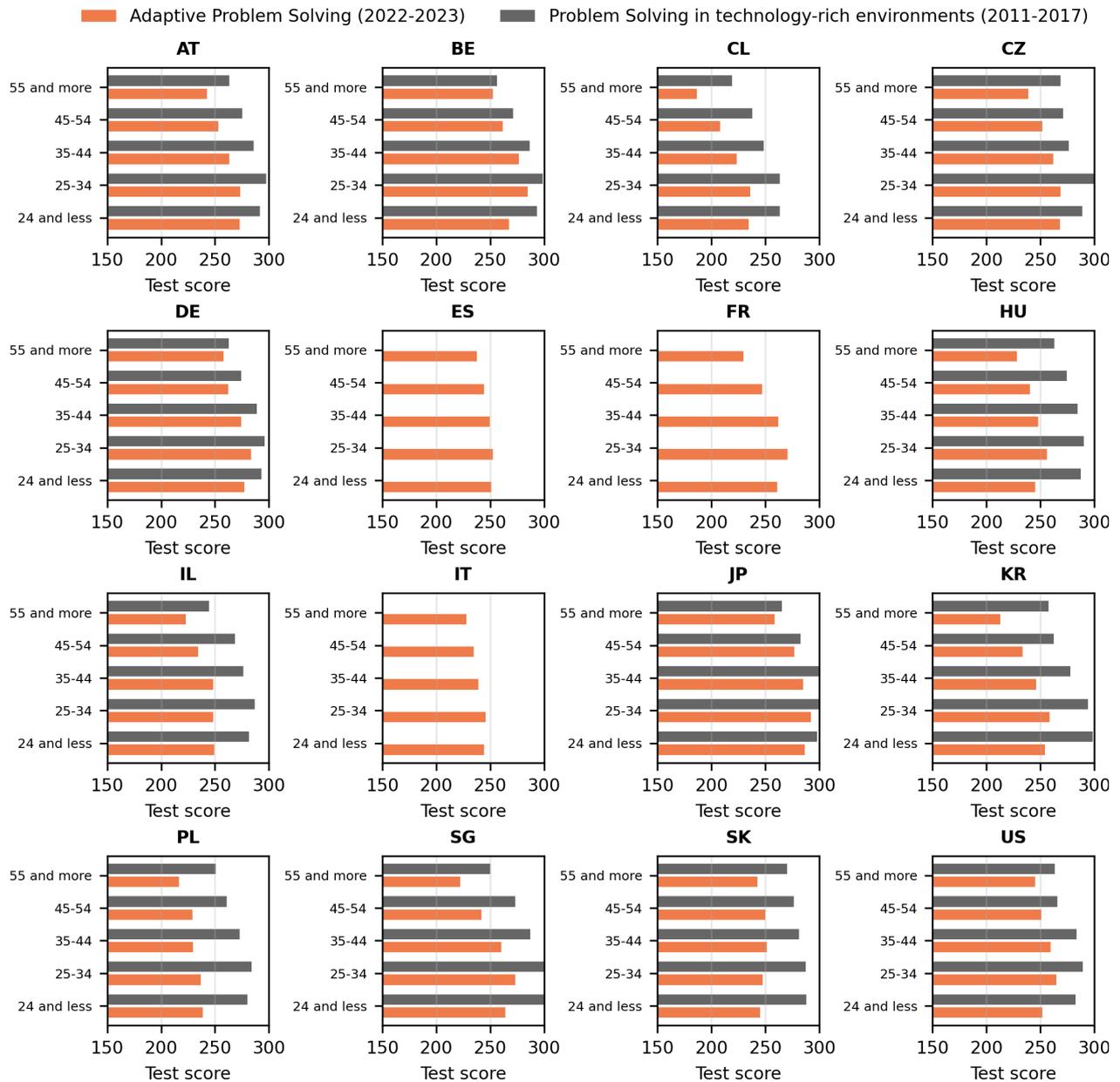
Next, we turn to problem-solving skills, which can serve as a proxy for the supply of technology-capable labour. Although test scores from the two PIAAC cycles are not directly comparable due to changes in the assessment framework, they consistently measure competencies essential for functioning in technology-rich environments.

Figure 2 Literacy and numeracy test scores for the first and second PIAAC cycle, by country and gender



Source: Own calculations based on PIAAC data. For 12 out of 16 countries studied here, the first cycle PIAAC data were collected in 2011-2012 (AT, BE, CZ, DE, ES, FR, JP, IT, KR, PL, SK, US), for three in 2014-2015 (CL, IL, SG), and for one in 2017-2018 (HU).

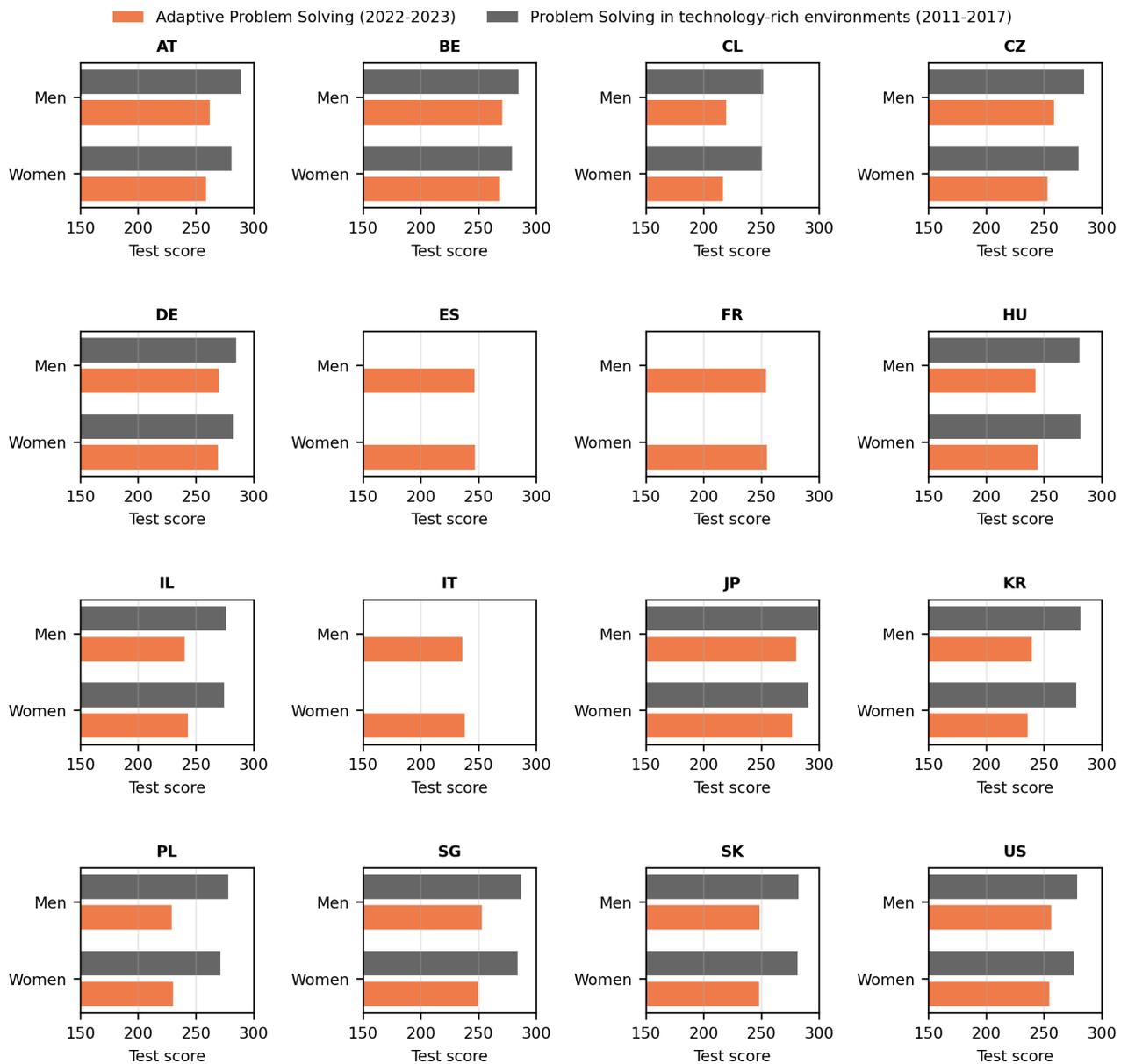
Figure 3 Adaptive problem solving and problem solving in technology-rich environments test scores, by country and age



Source: Own calculations based on PIAAC data. For 12 out of 16 countries studied here, the first cycle PIAAC data were collected in 2011-2012 (AT, BE, CZ, DE, ES, FR, JP, IT, KR, PL, SK, US), for three in 2014-2015 (CL, IL, SG), and for one in 2017-2018 (HU).

Across most countries, the age profiles of both problem solving in technology-rich environments and adaptive problem solving follow a remarkably similar pattern. Workers aged 25–34 consistently achieve the highest scores, reflecting peak performance in digital and adaptive cognitive tasks, while the youngest group—those under 24—typically ranks just below them (Figure 3). At the other end of the

Figure 4 Adaptive problem solving and problem solving in rich technology-rich environments test scores, by country and gender



Source: Own calculations based on PIAAC data. For 12 out of 16 countries studied here, the first cycle PIAAC data were collected in 2011-2012 (AT, BE, CZ, DE, ES, FR, JP, IT, KR, PL, SK, US), for three in 2014-2015 (CL, IL, SG), and for one in 2017-2018 (HU). Surveys in France, Italy and Spain did include problem-solving in rich technology-rich environments.

distribution, workers aged 55 and above generally record the lowest proficiency levels, highlighting a persistent generational gap in technology-related problem-solving skills. Gender differences are minimal in both assessments, with only occasional, small advantages for men (Figure 4). Turning to cross-country patterns, Japan, Germany, and Belgium stand out with the highest adaptive problem-solving scores, whereas Chile, Poland, and Italy score lowest in this domain. A similar structure appears

in the earlier PIAAC measure of problem solving in technology-rich environments, where Japan, Singapore, and Austria lead the rankings, and Chile, Poland, and Israel occupy the lower end.

3.2. Routine task intensity developments

We first compare RTI in the United States between PIAAC Cycle 1 and Cycle 2 (Figure 5), as the US in Cycle 1 serves as the benchmark for standardisation. All RTI values are demeaned and normalised using the US mean and standard deviation from PIAAC Cycle 1.

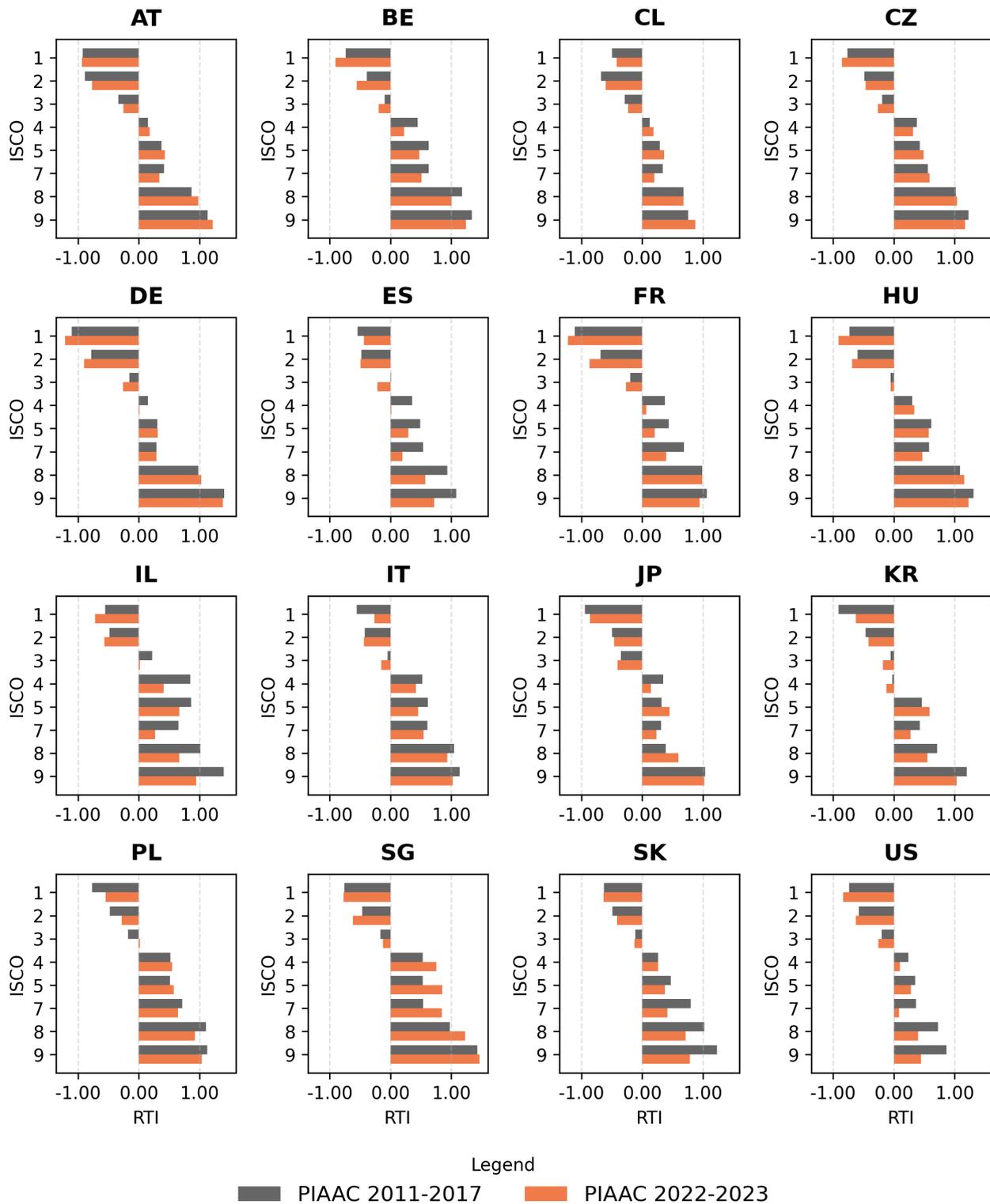
In the US, RTI decreased across all major ISCO groups, indicating a general decline in the routine content of work. High-skilled occupations (ISCO 1–3) remain less routine-intensive than the average US job and have become even less routine over time. Middle-skilled occupations (ISCO 4–5) also show a marked decline, with clerical workers (ISCO 4) experiencing the largest relative reduction, though still displaying above country-average RTI. Low-skilled occupations (ISCO 7–9) exhibit smaller but consistent decreases.

The overall ranking of occupations by routine intensity remains unchanged: high-skilled jobs continue to be the least routine, and low-skilled jobs the most routine. Hence, while the level of routine task intensity declined across the occupational structure, its relative pattern remained stable between the two PIAAC cycles.

Across countries, the routine task intensity (RTI) of work generally declined between PIAAC Cycle 1 and Cycle 2, indicating a broad shift away from routine tasks. The decline is evident across the occupational structure but is particularly pronounced among low-skilled occupations (ISCO 7–9), which traditionally involve a high share of routine manual and service activities. Middle-skilled occupations (ISCO 4–5), especially clerical support workers (ISCO 4), also experienced a significant decline in average RTI. In contrast, the pattern among high-skilled occupations (ISCO 1–3) is more heterogeneous: in several countries—such as Chile, Poland, and Singapore—RTI increased for some high- or middle-skill groups.

Taken together, these results reveal two consistent patterns. First, there is a global tendency toward reduced routine intensity, at least among lower- and upper-tier high-income countries, driven primarily by declines among low- and middle-skilled occupations. Second, substantial cross-country variation remains, with some economies showing stable or even rising RTI in higher-skilled jobs. These differences suggest that aggregate declines in routine task intensity reflect both changes in occupational structure and within-occupation adjustments in task composition.

Figure 5 Routine task intensity (RTI) in the first and second PIAAC cycle, by country



Source: Own calculations based on PIAAC data. For 12 out of 16 countries studied here, the first cycle PIAAC data were collected in 2011-2012 (AT, BE, CZ, DE, ES, FR, JP, IT, KR, PL, SK, US), for three in 2014-2015 (CL, IL, SG), and for one in 2017-2018 (HU).

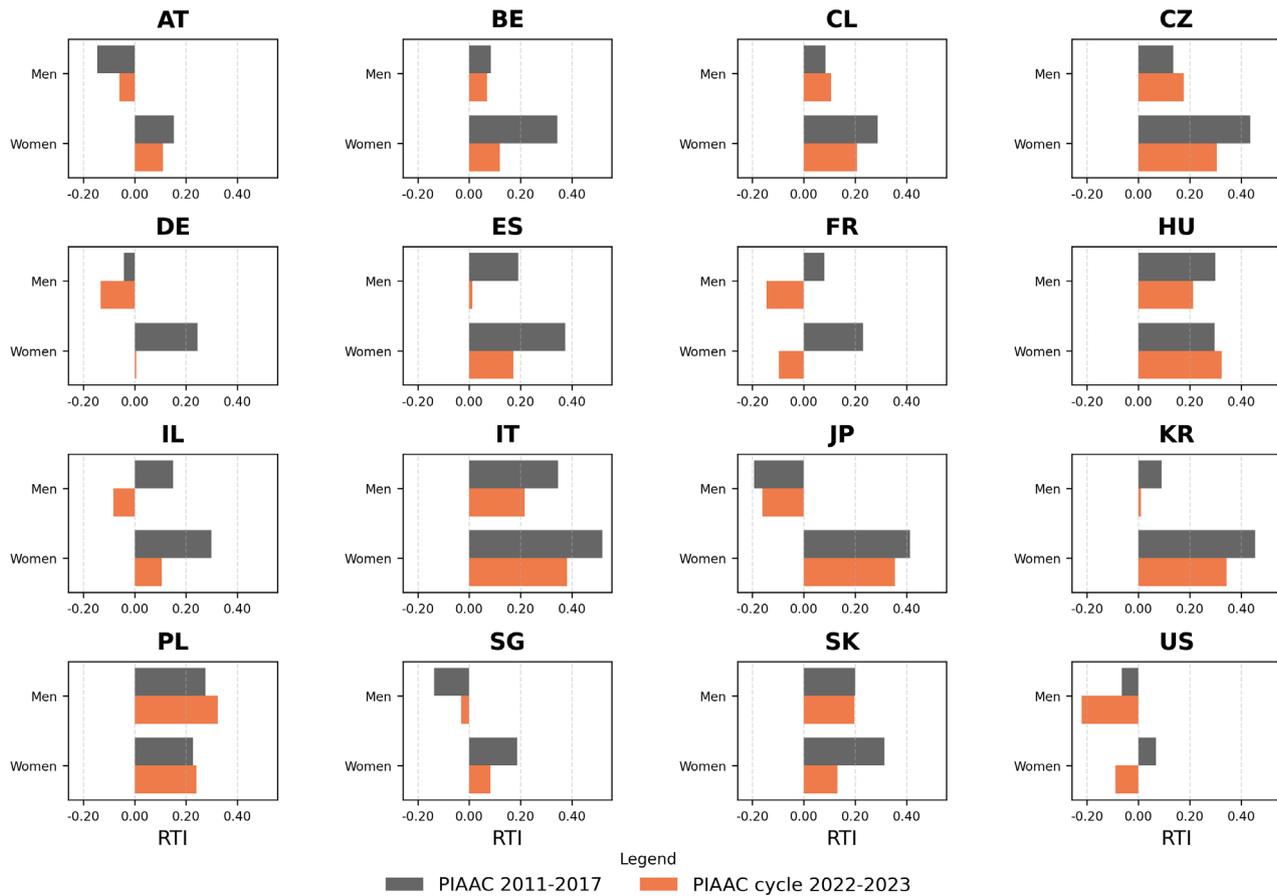
Next, we explore the routine task intensity across sociodemographic dimensions. In nearly all countries, women consistently exhibit higher RTI levels than men, indicating that they remain more concentrated in routine-intensive occupations (Figure 6). Poland constitutes the sole exception, where men were, and continue to be, more engaged in routine-intensive work. In Slovakia, the gender pattern observed in the first cycle reversed over time, as women's RTI declined below that of men by 2022, suggesting a reconfiguration of gendered task structures.

In several countries, notable changes over time are observed. Among men, RTI increased in the Czech Republic and Poland (both now above the US 2012 level) and in Austria and Japan (where it remains below the US 2010 level despite an increase). Among women, increases in RTI were recorded only in Hungary and Poland, whereas in other countries, women's routine tasks intensity declined.

Overall, the gender gap in RTI appears to narrow over time, primarily reflecting a more pronounced decline in women's routine task intensity relative to men's. This convergence suggests gradual structural adjustments in the occupational composition of employment, leading to a partial equalisation in the task content of men's and women's work.¹

¹ The shift-share decomposition of changes in women's RTI shows that the between-occupation component accounts for about 26% of the cross-country variance, compared with only 3% among men. This suggests that not only is the task content of women's occupations becoming less routine, but women are also increasingly concentrated in less routine-intensive jobs.

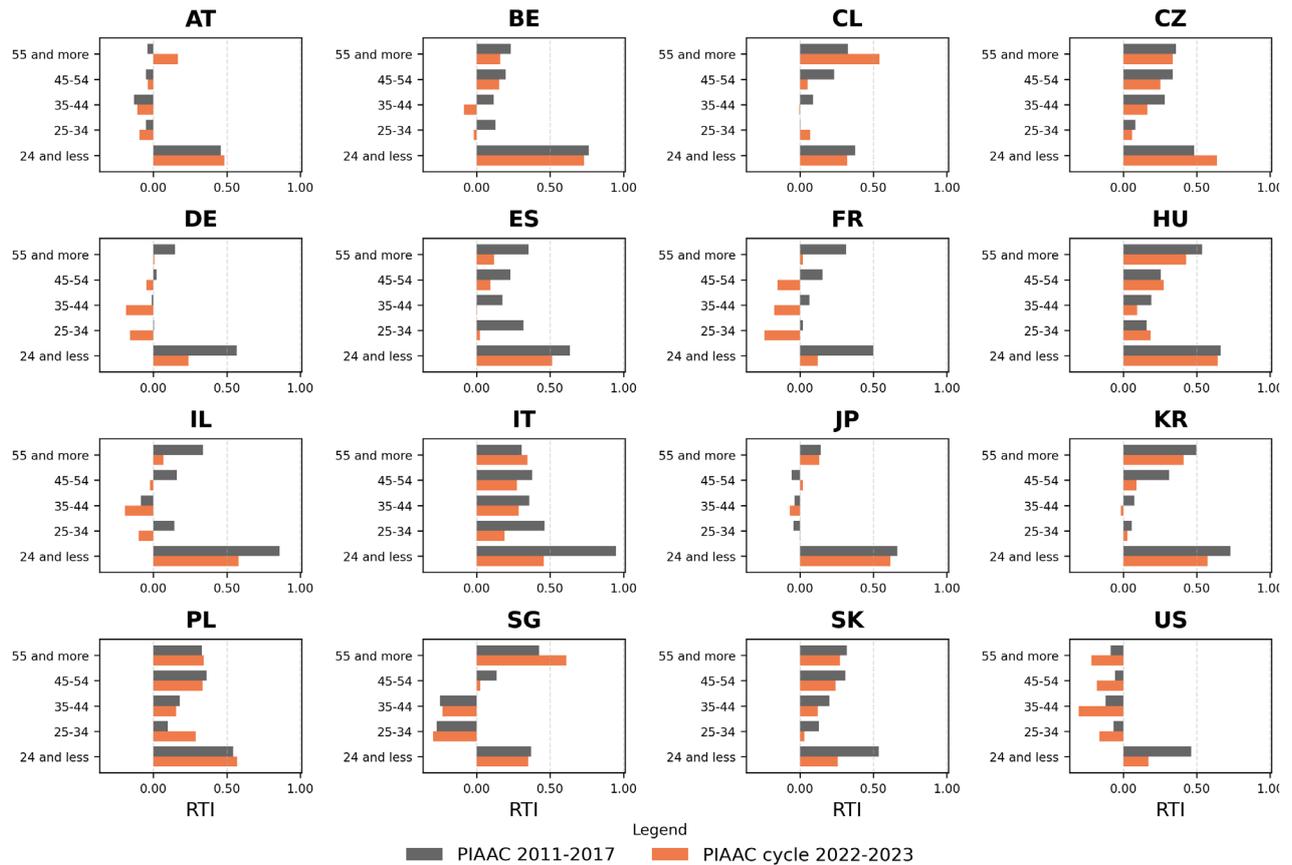
Figure 6 Routine task intensity (RTI) in the first and second PIAAC cycle, by country and gender



Source: Own calculations based on PIAAC data. For 12 out of 16 countries studied here, the first cycle PIAAC data were collected in 2011-2012 (AT, BE, CZ, DE, ES, FR, JP, IT, KR, PL, SK, US), for three in 2014-2015 (CL, IL, SG), and for one in 2017-2018 (HU).

Turning to the age dimension, age does not appear to be a key factor differentiating Routine Task Intensity (RTI) across countries (Figure 7). In most cases, workers in all age groups perform, on average, more routine-intensive jobs than the US 2012 level. Within countries, two consistent patterns emerge. First, the youngest workers (under 24 years old) tend to engage in the most routine-intensive jobs, with the notable exceptions of Chile and Singapore, where the oldest group (aged 55 and above) exhibits the highest RTI. Second, prime-aged workers generally perform the least routine-intensive jobs, indicating that task intensity tends to decline with age before increasing again among the oldest cohorts in some countries.

Figure 7 Routine task intensity (RTI) in the first and second PIAAC cycle, by country and age



Source: Own calculations based on PIAAC data. For 12 out of 16 countries studied here, the first cycle PIAAC data were collected in 2011-2012 (AT, BE, CZ, DE, ES, FR, JP, IT, KR, PL, SK, US), for three in 2014-2015 (CL, IL, SG), and for one in 2017-2018 (HU).

4. Conclusions

The evolution of job tasks in high-income economies over the past decade confirms that digitalisation continues to reshape the nature of work, but not in uniform ways. Using harmonised microdata from two cycles of PIAAC, we provide systematic evidence on how skill supply and routine task intensity (RTI) have changed across 16 countries. Our results demonstrate a clear, cross-country decline in routine work, indicating a persistent shift away from codifiable and standardised activities and toward more complex, judgement-based tasks. Yet, this decline is far from homogeneous: countries and demographic groups have experienced the transition at different speeds and along different paths .

Demographic patterns persist—women and younger workers perform more routine-intensive tasks—but the gender gap narrows over time, suggesting gradual structural adjustments in labour allocation. Nonetheless, significant differences remain, underscoring the need for targeted policies that align skill development with evolving task structures.

Overall, the findings imply that digital transformation will not eliminate routine work, but will continue to reconfigure it. Policy responses should therefore prioritise strengthening foundational and transversal skills, supporting lifelong learning, and ensuring that workers can complement rather than be displaced by new technologies. The uneven impact of emerging digital tools further emphasises the importance of nuanced policies that recognise the distinct pathways through which technologies influence job tasks. As technological diffusion progresses, economies equipped with adaptable skill systems will be better positioned to harness the benefits of digitalisation and mitigate its risks.

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