

Online annex for BIS Bulletin no 135: “Old workers, young machines: can AI and automation offset population ageing?”

Data and methods

Data. Industry-level ageing is defined here as the share of employees in an industry aged 55 and over, built from the International Labour Organization (ILO) employment-by-age-and-activity data for more than 160 economies, classified by International Standard Industrial Classification (ISIC) Rev. 4 section (A–U) and averaged over 2021–24.

National ageing trajectories and dependency ratios use the United Nations (UN) World Population Prospects 2024 (medium variant). GDP per capita is from World Bank data in current US dollars for 2024.

AI exposure is the AI Industry Exposure index of Felten et al (2021), defined at the four-digit North American Industry Classification System (NAICS) level; it is aggregated to ISIC sections through an NAICS-to-ISIC concordance, weighted by employment using US industry employment. The Felten et al (2021) index correlates closely with other AI measures, as shown in Eloundou et al (2024).

Robot exposure is the adjusted penetration of robots from Acemoglu and Restrepo (2020) for 19 industries of the International Federation of Robotics; its 13 manufacturing sub-industries are combined into ISIC section C by an employment-weighted mean. Its near zero services value is assigned to the service sections. We log-transform the robot exposure measure to limit the influence of the manufacturing outlier.

Overlap. For each jurisdiction, the ageing-automation overlap is the employment-weighted covariance across industries between the industry 55+ employment share and combined AI-robot exposure: $overlap = \sum w(a - \bar{a})e$, where w is the industry employment share, a is the industry 55+ employment share, $\bar{a}$ is the national employment-weighted 55+ share and e is the standardised combined AI-robot exposure defined in the main text. Netting out $\bar{a}$ removes the national ageing level, so the measure captures industrial composition rather than the overall level of ageing.

High-exposure employment share. We define high-exposure industries as the top quartile of the 19 ISIC sections ranked by combined AI-robot exposure. This comprises manufacturing, finance and insurance, professional and technical services, education, and information and communications. For each jurisdiction, the measure is the share of workers aged 55 and over employed in these industries.

Robustness and coverage. The jurisdiction ranking is robust to using AI or robot exposure alone, and a correlation-normalised version preserves the ordering. Saudi Arabia is absent from the ILO industrial cross-tabulation; data for China, Canada and South Africa have been added from national sources (2020 Chinese census, 2021 Canadian census and the ILO ISIC Rev. 3.1 series for South Africa). Economies with fewer than 12 covered sections, and small economies, are excluded from the charts. Exposure is technical potential, not realised adoption. Graph A1.B plots the overlap against GDP per capita, with and without sub-Saharan Africa.

Industry-level automation exposure, ordered by AI-robot exposure

Table A.1

ISIC	Industry	AI exposure	Robot exposure	AI-robot exposure
C	Manufacturing	-0.42	4.24	1.91
K	Finance & insurance	2.08	-0.26	0.91
M	Professional & technical	1.71	-0.26	0.72
P	Education	1.31	-0.15	0.58
J	Information & comms	1.11	-0.26	0.43
Q	Health & social work	0.63	-0.26	0.19
L	Real estate	0.49	-0.26	0.11
O	Public admin	0.36	-0.26	0.05
D	Utilities	0.19	-0.20	0.00
G	Trade	0.08	-0.26	-0.09
S	Other services	-0.25	-0.26	-0.25
B	Mining	-0.48	-0.13	-0.31
H	Transport	-0.55	-0.26	-0.41
N	Admin & support	-0.68	-0.26	-0.47
R	Arts & recreation	-0.74	-0.26	-0.50
E	Water & waste	-0.94	-0.26	-0.60
I	Accommodation & food	-1.04	-0.26	-0.65
F	Construction	-1.15	-0.22	-0.69
A	Agriculture	-1.70	-0.18	-0.94

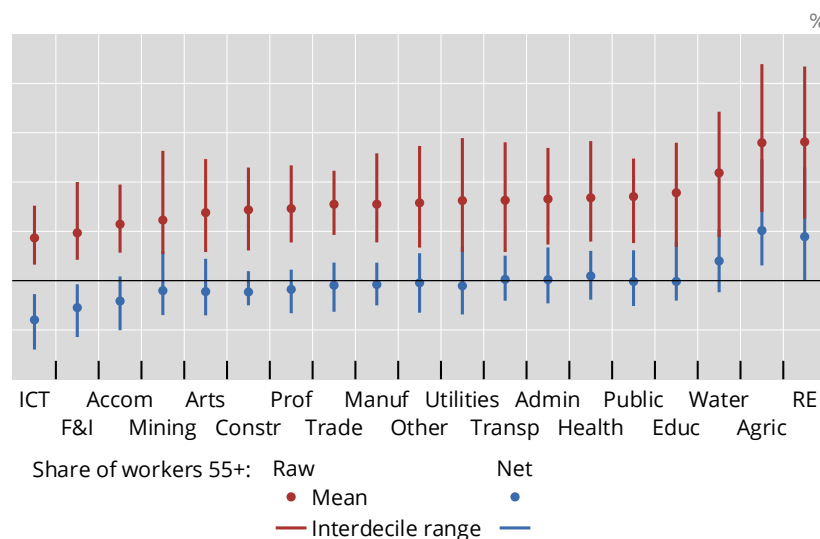
Standard deviations across ISIC Rev. 4 sections. AI exposure: Felten et al (2021), AI Industry Exposure. Robot exposure: Acemoglu and Restrepo (2020), adjusted robot penetration (log-transformed before standardising). Composite: simple, equally weighted average of the two. Industries ordered by composite AI-robot exposure.

Sources: Acemoglu and Restrepo (2020); Felten et al (2021); authors' calculations.

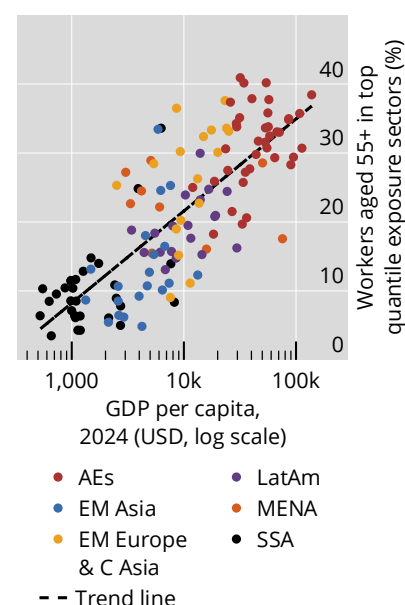
Ageing dispersion and the correlation of automation exposure with income

Graph A.1

A. Within industries, ageing differs across jurisdictions¹



B. The share of workers in high-exposure industries is positively correlated with income²



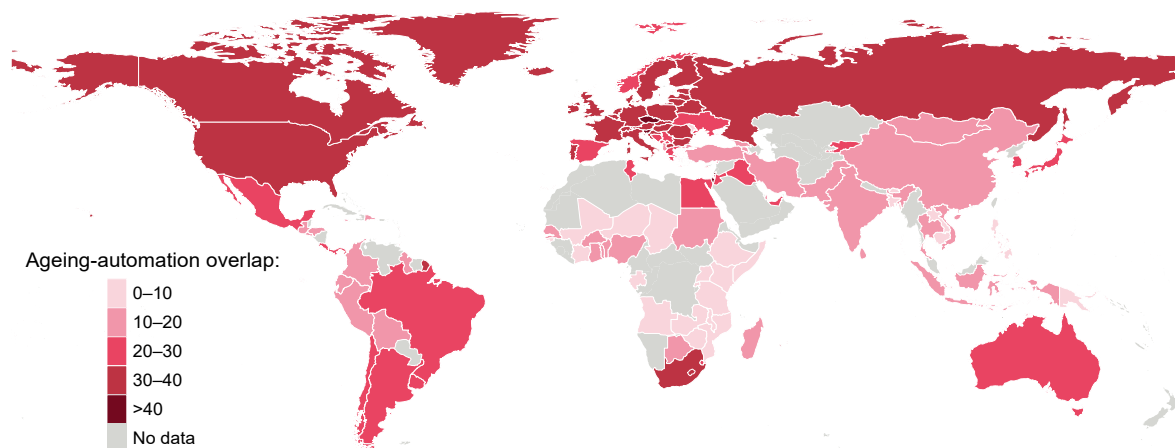
¹ For industries' full names, see the notes to Graph 1. ² For regions' full names, see the notes to Graph 1.

Sources: Acemoglu and Restrepo (2020); Felten et al (2021); International Labour Organization, ILOSTAT; World Bank, World Development Indicators; authors' calculations.

Share of employment in the top quartile of exposed industries¹

In per cent

Graph A.2



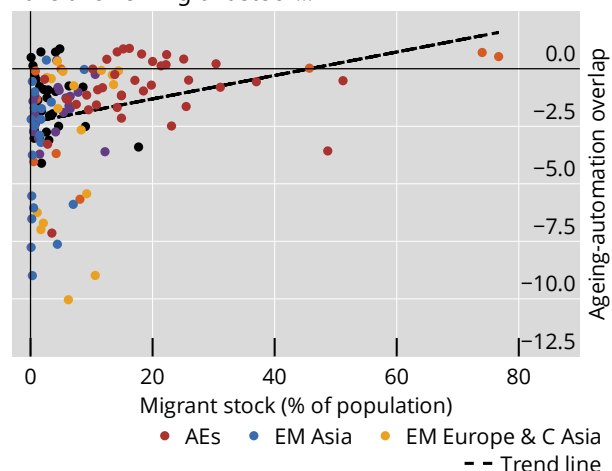
¹ Share of 55+ population in the quartile of industries with the highest AI-robot exposure (“high-exposure employment share”). The use of this map does not constitute, and should not be construed as constituting, an expression of a position regarding the legal status or sovereignty of any territory or its authorities, the delimitation of international frontiers and boundaries, and/or the name and designation of any territory, city or area.

Sources: Acemoglu and Restrepo (2020); Felten et al (2021); International Labour Organization, ILOSTAT; World Bank; authors’ calculations.

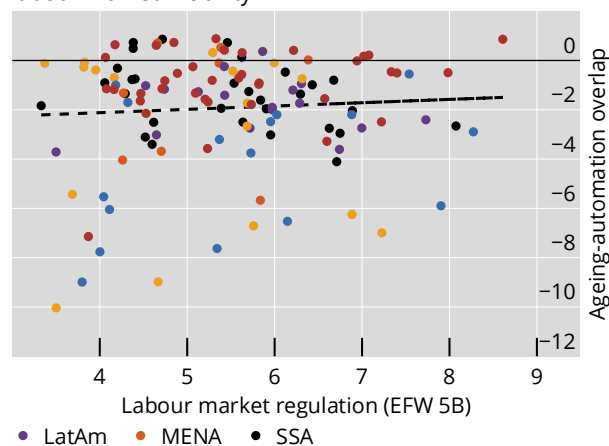
Countries with lower automation potential have a lower migrant stock¹

Graph A.3

A. Countries with a worse ageing-automation overlap have a lower migrant stock...



B. ...and there is no correlation between the overlap and labour market mobility²



¹ See above for the definition of the overlap measure. See the notes to Graph 1 for regions’ full names. ² EFW = Economic Freedom of the World Index. Component 5B evaluates the extent to which individuals and businesses can voluntarily negotiate employment terms, wages, and hiring or firing conditions. A higher score (on a scale of 0 to 10) indicates fewer regulatory constraints, greater flexibility and higher labour mobility.

Sources: United Nations, *World Population Prospects 2024*; International Labour Organization, ILOSTAT; Fraser Institute; authors’ calculations.

Overlap, high-exposure employment share and ageing in major economies¹

Table A.2

	Overlap score	High-exposure share, %	55+ share of employment, %
USA	0.9	35.0	23.4
CHN	-7.8	12.3	17.2
DEU	-0.7	35.8	26.3
JPN	-3.3	25.7	31.6
IND	-3.8	10.7	16.1
GBR	-0.5	33.6	21.4
FRA	-0.3	31.7	20.2
ITA	-0.9	37.9	24.1
CAN	0.2	30.7	23.0
BRA	-1.2	23.9	13.9
RUS	-0.1	32.4	17.6
KOR	-7.1	20.6	33.3
MEX	-3.0	23.2	17.4
AUS	0.2	29.3	19.7
ESP	-1.0	27.2	20.1
IDN	-5.5	12.7	19.8
TUR	-5.7	16.1	13.1
NLD	0.9	33.1	22.6
POL	-1.7	33.2	17.9
CHE	-0.8	35.7	22.5
BEL	0.3	33.8	19.1
ARG	0.4	30.0	16.9
SWE	0.1	37.7	23.5
IRL	-2.5	30.7	19.4
ARE	0.7	28.6	6.1
SGP	-3.6	29.4	27.3
AUT	-1.6	32.5	19.0
THA	-7.6	11.1	23.1
ISR	0.6	40.2	20.6
NOR	0.6	28.3	22.2

More favourable
Neutral
Less favourable

¹ The table includes the 30 largest jurisdictions by GDP as of 2024, scored on the three measures. Each cell is coloured by tercile within the group of 30 jurisdictions these 30, so the colours are relative to this peer group. Overlap score: higher values = more favourable (green); high-exposure share: higher values = more favourable (green); 55+ share of employment: lower values = more favourable (green, direction reversed).

Sources: Acemoglu and Restrepo (2020); Felten et al (2021); International Labour Organization, ILOSTAT; World Bank; authors' calculations.