

Effects of automation on workers: future of work and income inequality

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Outline

- Recent trends in technological progress and the development of automation technologies
- Drivers of automation
- Robot and its impact on employment and income inequality
- The geography of innovation and future markets: a capability perspective

New technologies around the corner

- A new wave of technological progress: the rise of Industry 4.0, advanced robotics, big data analytics, and artificial intelligence
- Industry 4.0 is enabled by four key drivers:
 - rising data volumes, computational power and connectivity
 - the emergence of analytics and business-intelligence capabilities
 - new forms of human-machine interaction, such as touch interfaces and augmented-reality systems and
 - improvements in transferring digital instructions to the physical world, such as robotics and 3D printing.

New technologies around the corner

- New developments in robotics and artificial intelligence foreshadow a new bias, from both low- and high-skill workers toward capital.
- AI vs. simpler automation of single tasks: While simple automation has proliferated for decades and will continue, AI brings a comparatively new pattern of replacement of both low-skill and professional workers.
- Indeed, Sachs et al. (2015) define the essential quality of AI as “[allowing] output without labour”. This change in bias makes it likely that historical patterns of technical change are of limited use in predicting change and analyzing the effects of policies to address it.

The market of robots and automation technologies

- The market of robots is growing rapidly. According to the International Federation of Robotics (IFR), since 2010, the demand for industrial robots has accelerated considerably. 2011-2016: 12% growth in industrial robot sales per year; the average annual supply rose to about 212,000 units, which is an increase of about 84% compared to the average annual supply between 2005 and 2008.
- Australasia is the world's strongest growth market for industrial robots, followed by Europe and Americas (Figure 3).

The market of robots and automation technologies

Figure 1. Estimated annual shipments of industrial robots by regions

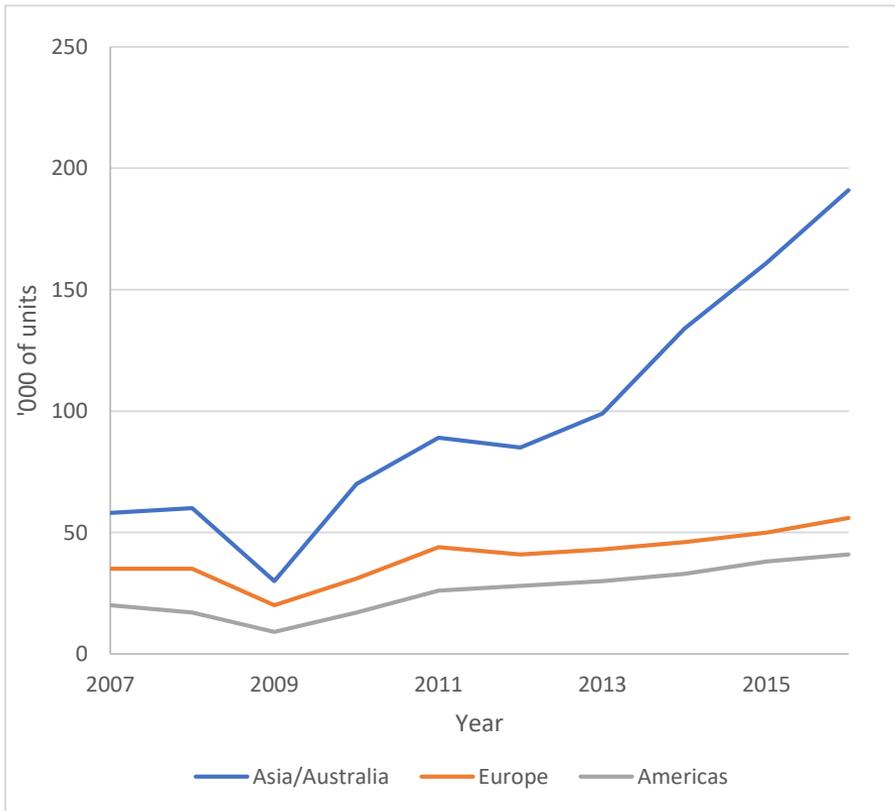
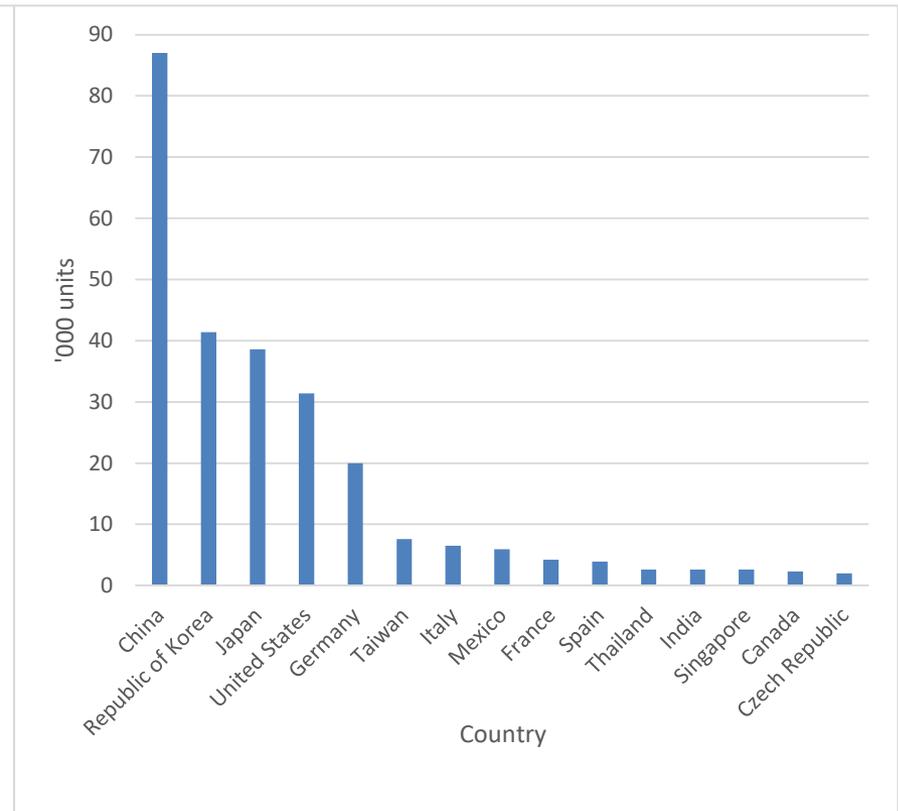


Figure 2. Annual supply of industrial robots in fifteen largest markets in 2016



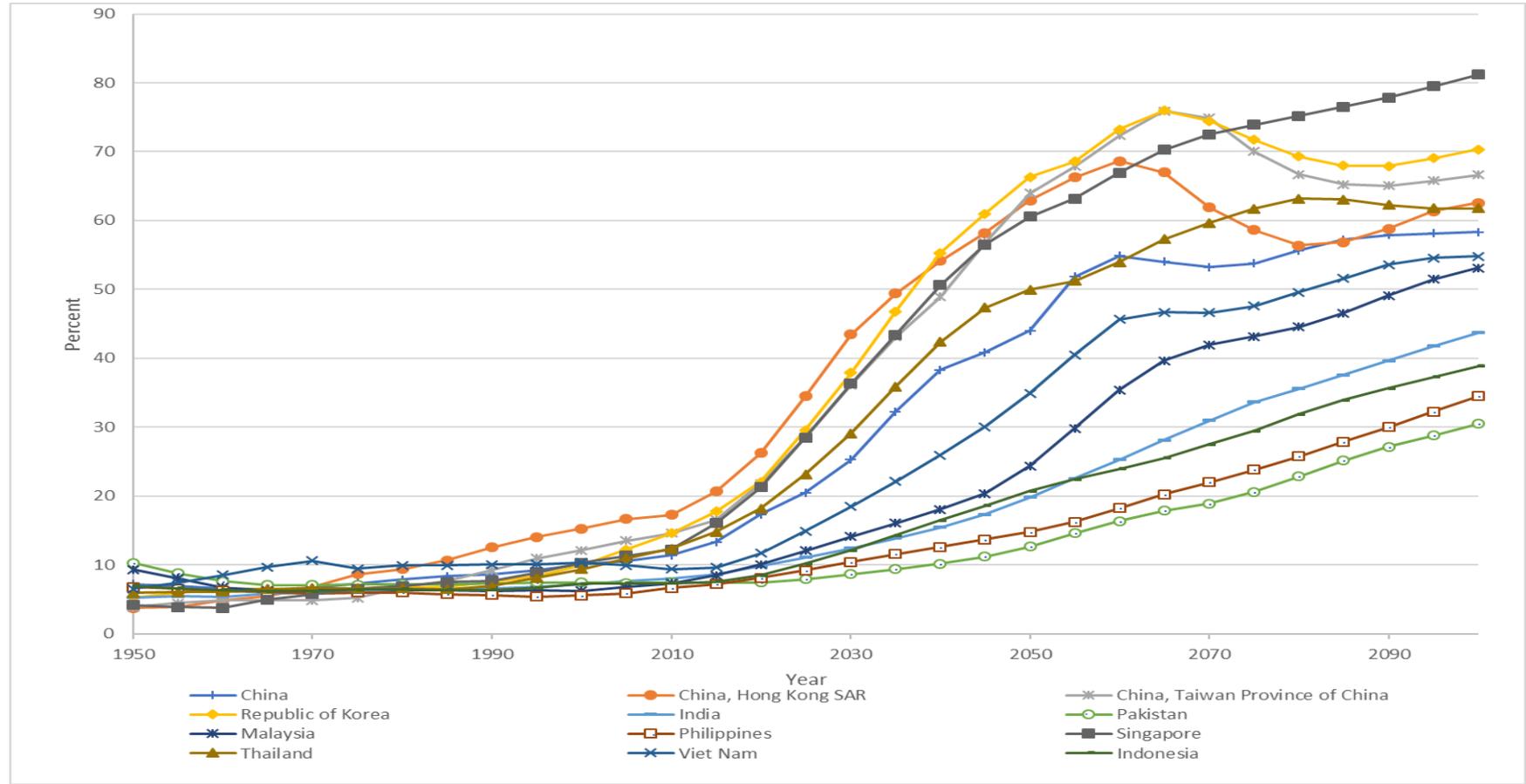
Source: International Federation of Robotics (2017).

The market of robots and automation technologies

- Robot intensity (the number of industrial robots per 10,000 persons employed in manufacturing):
 - Global average: 74
 - Republic of Korea: 631
 - Singapore: 488
 - Germany: 309
 - Japan: 303
 - United States: 189
 - Europe average: 99
 - Americas average: 84
 - China: 68
 - Asia average: 63

Drivers of automation: population aging

Figure 3. Dependency ratios in selected Asian economies, defined as population aged 65 and older as a share of population aged 15 to 64, 1950-2100



Source: United Nations (2017).

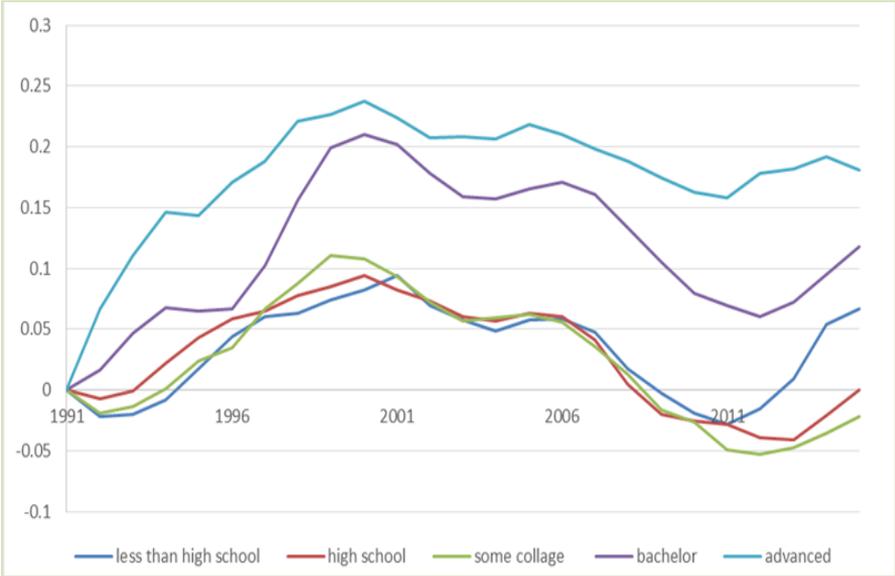
Drivers of automation: maintaining cost advantage in international markets

- Unit labour costs (ULC), a broad measure of international price competitiveness, is the average cost of labour per unit of output produced. They can be expressed as the ratio of labour cost per worker to output per worker (labour productivity) (OECD, 2017).
- Countries in the Asia Pacific Region overall have achieved stronger international price competitiveness compared with advanced economies. However the fall of ULC is slowing down as the catch-up of developing Asia's labour productivity has gradually plateaued post GFC, as seen in Figure 8.
- To maintain competitiveness in the international markets, firms are investing in automation to enhance labour productivity. Firms in advanced economies are also ramping up investment in automation and artificial intelligence to maintain the lead in labour productivity and thus their competitiveness..

Concern over the rise of robots, job polarization and income inequality

- In the last several decades, substantial changes in wage inequality and job polarization occurred in most advanced economies.
- Two main causes of job polarization in advanced economies are automation and offshoring (Acemoglu and Restrepo, 2017; Acemoglu and Autor, 2011; Nordhaus, 2007; Autor et al., 2003;) .

Figure 4. Percent changes in U.S. mean real income from the level in 1991, male above 25 years old (1991-2015)



Source: Figure 4 in Tyers and Zhou (2017).

How will automation affect economic development?

- Reshoring?
- The geography of innovation and future markets

The geography of innovation and future markets: a capability perspective

Table 1. People with completed tertiary education as percentage of population aged 25 and over

Country	completed tertiary, % of population aged 25 and over
Republic of Korea	34.8
USA	30.9
Singapore	30.6
Australia	25.2
Mongolia	22.5
Japan	19.9
United Kingdom	18.8
Germany	16.1
China, Hong Kong	14.8
China, Macao Special Administrative Region	12.3
Thailand	10.0
Sri Lanka	9.5
Taiwan	8.6
Philippines	7.2
India	6.1
Malaysia	5.9
Pakistan	5.5
Myanmar	4.9
Vietnam	4.6
Bangladesh	3.1
China	2.4
Nepal	2.3

Source: Barro and Lee (2013)

The geography of innovation and future markets: a capability perspective

Table 2. Ease of doing business, infrastructure, legal protection and ease of exporting in selected countries in the Asia Pacific Region

Country	2016 Logistics performance index: Overall (1=low to 5=high)	2016 Strength of legal rights index (1=weak to 12=strong)	2014 Time to export (days)	2017 Ease of doing business index (1=most business-friendly to 190=least)
Singapore	4.1	8	6	2
Korea, Rep.	3.7	5	8	4
Hong Kong SAR, China	4.1	8	6	5
United States	4.0	11	6	6
Australia	3.8	11	9	14
Malaysia	3.4	7	11	24
Thailand	3.3	3	14	26
Japan	4.0	5	11	34
Vietnam	3.0	7	21	68
Indonesia	3.0	6	17	72
China	3.7	4	21	78
India	3.4	6	17.1	100
Nepal	2.4	6	40	105
Sri Lanka	N.A.	2	16	111
Philippines	2.9	1	15	113
Bangladesh	2.7	5	28.3	177

Source: World Development Indicators (2017).