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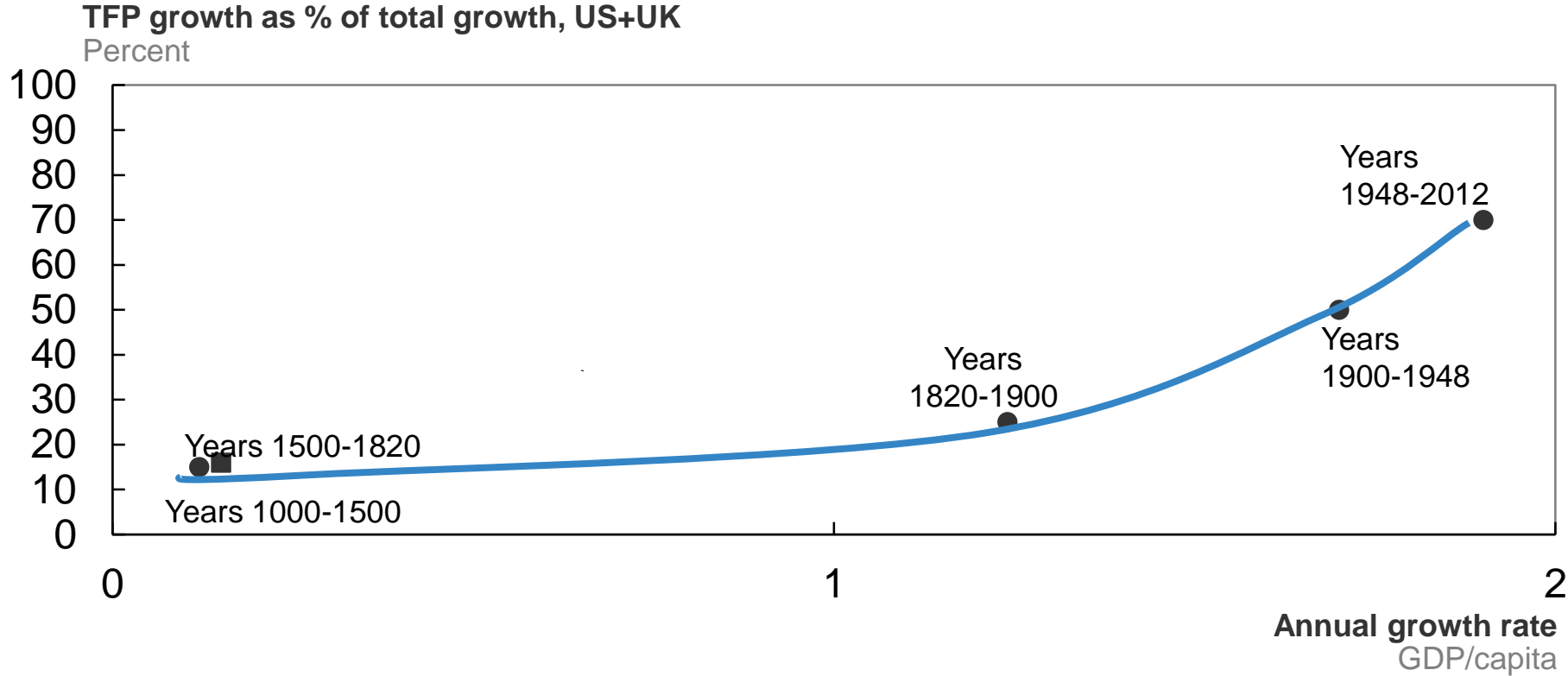
# Future Ready Graduates

JONATHAN WOETZEL

EHELF | June 2019



# Tech is becoming the major driver of global growth



SOURCE: Maddison; OECD; Jones; McKinsey

# Amazing progress in AI

1

## Algorithms/techniques

Neural Networks, CNNs, RNNs, Deep learning, Reinforcement Learning...

2

## Compute power

Silicon (CPUs, GPUs, TPUs ...); Hyperscale compute capacity, cloud available ...

3

## Data

50 exabytes (2000), 300 exabytes (2007); 16 zettabytes (2016), 163 zettabytes (2025) ...

4

## Systems innovations

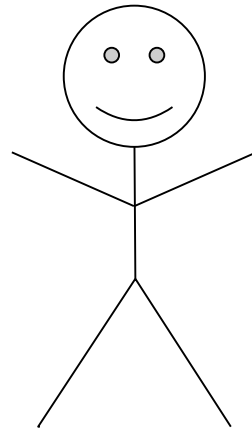
LIDAR, sensors, machine vision, mapping and navigation, robotic systems ...

2011



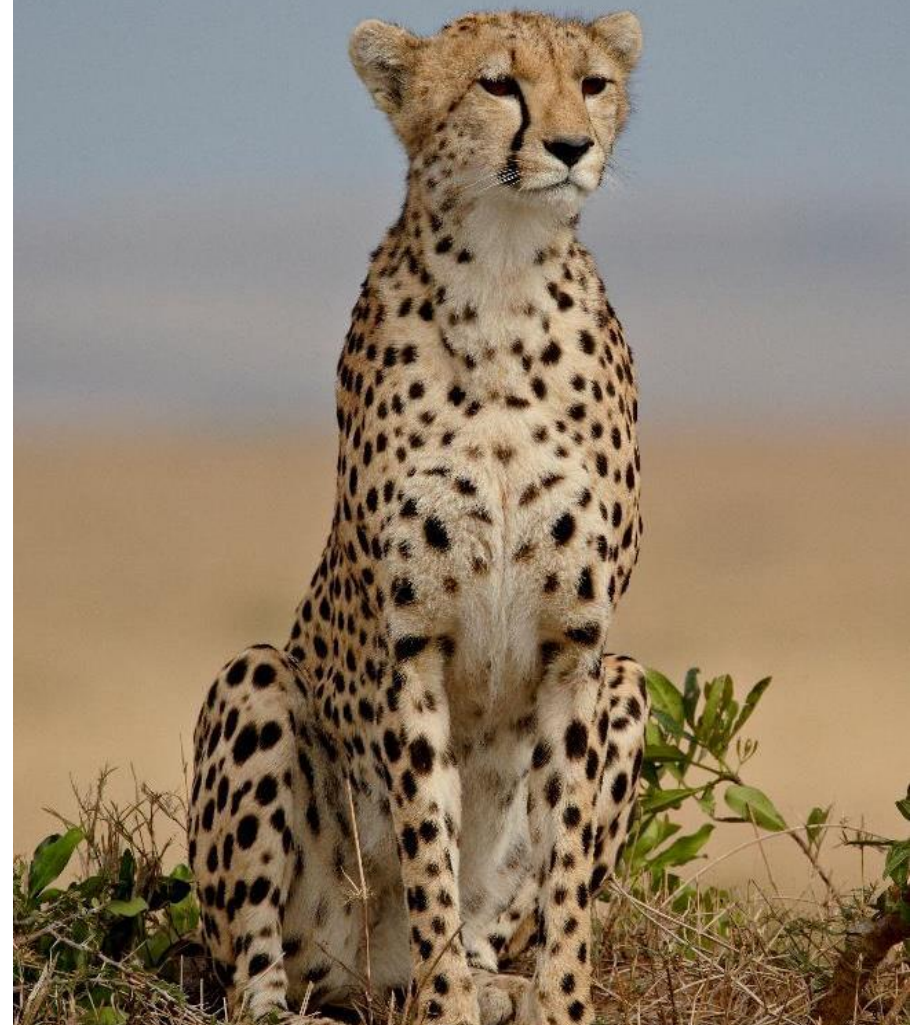
**26% errors**

Humans



**5% errors**

2016



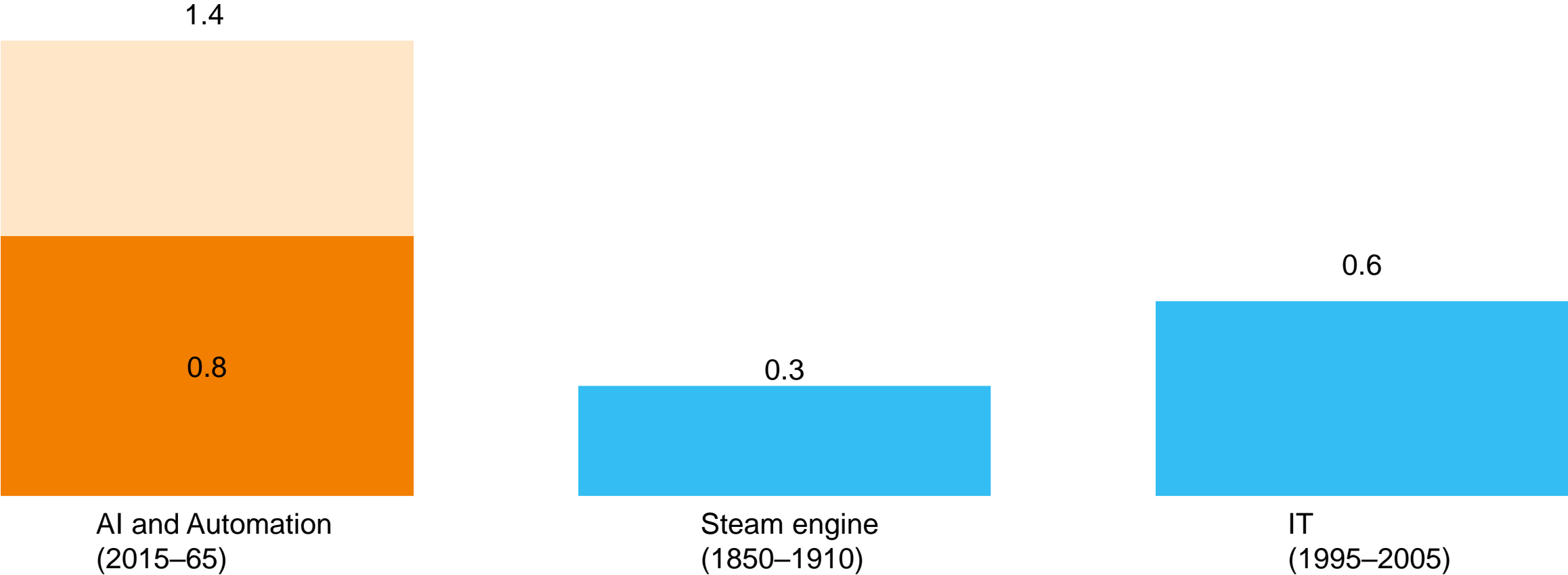
**3% errors**

# AI and automation and related digital technologies could increase productivity at magnitudes similar to other major technologies

## Productivity growth

Compound annual growth rate  
%

Earliest scenario Latest scenario



# Technology is challenging fundamental business orthodoxies

2005



2015

**Asset ownership**

500,000 rooms



2M+ rooms, no physical assets

**Distribution**

1,500 stores



No physical stores

**Production cycle**

12-18 month production cycle



Monthly software updates



# Case study: “New Retail”

Since early 2016, Alibaba has spent over

**\$3.4 B**

acquiring stakes in brick-and-mortar retail chains to build an integrated business model with online, offline, logistics, and data components





## Case study: Digital bank

The transaction volume on Ping An's Orange e-platform hit **\$220 billion** in 2016, soaring by

**92.5%**

year on year





## Case study: Online sales

Xiaomi expanded into the Indian market solely using “flash sales” on e-commerce website Flipkart, and now ranks

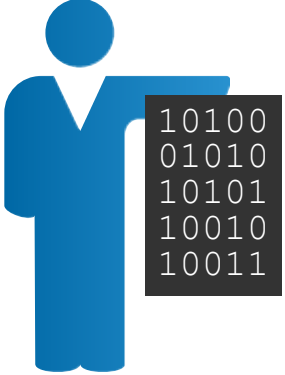
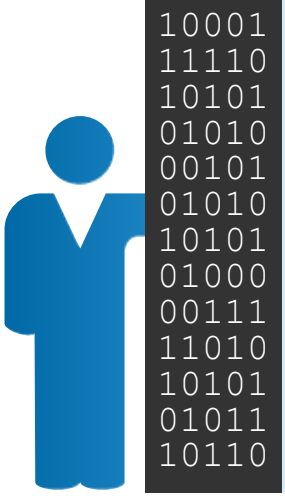
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2<sup>nd</sup> in India's  
smartphone sales

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# The most digitized (sectors, companies) see higher productivity and innovation



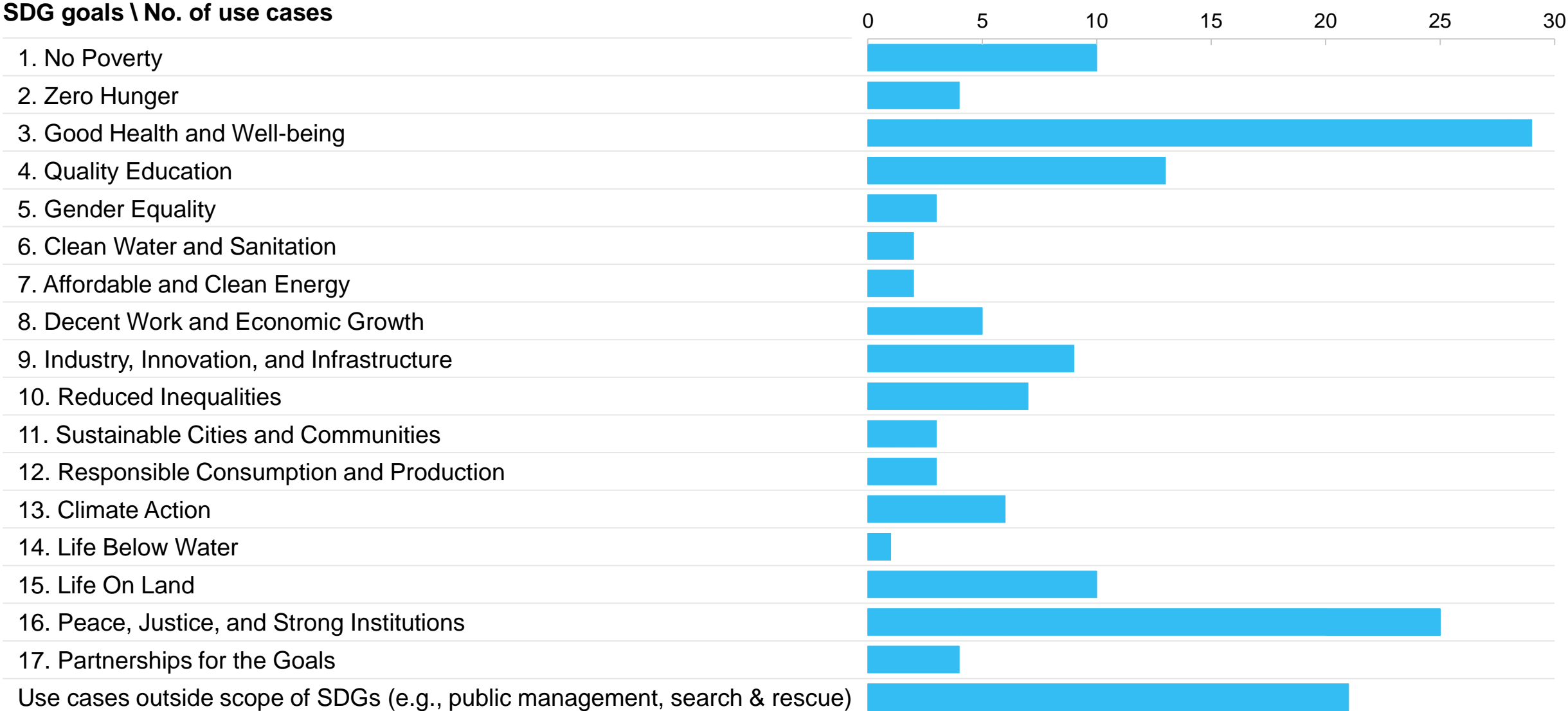
Faster revenue growth

3x faster profit and margin growth

Higher productivity and innovation

2x faster wage growth

# Many of the UN Sustainable Development Goals, and more, could benefit from AI use cases





A scientist in a white lab coat is working on a complex industrial machine with yellow robotic arms in a factory setting. The image is overlaid with a blue geometric pattern of lines and dots. The text is centered in white.

If AI is good for business, economy,  
and society, what about work?



# Our approach focuses on currently demonstrated technologies

## Occupations



Retail salespeople



Food and beverage service workers



Teachers



Health practitioners

- ...
- ...
- ...

**~800 occupations**

## Activities



Greet customers



Answer questions about products and services



Clean and maintain work areas



Demonstrate product features



Process sales and transactions

- ...
- ...
- ...

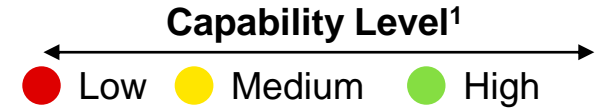
**~2,000 activities assessed across all occupations**

## Capabilities

- 1 Social
- 2 Linguistic
- 3 Cognitive
- 4 Sensory perception
- 5 Physical

Based on currently demonstrated technology capabilities

# We have identified 18 capabilities with varied ease of AI capability

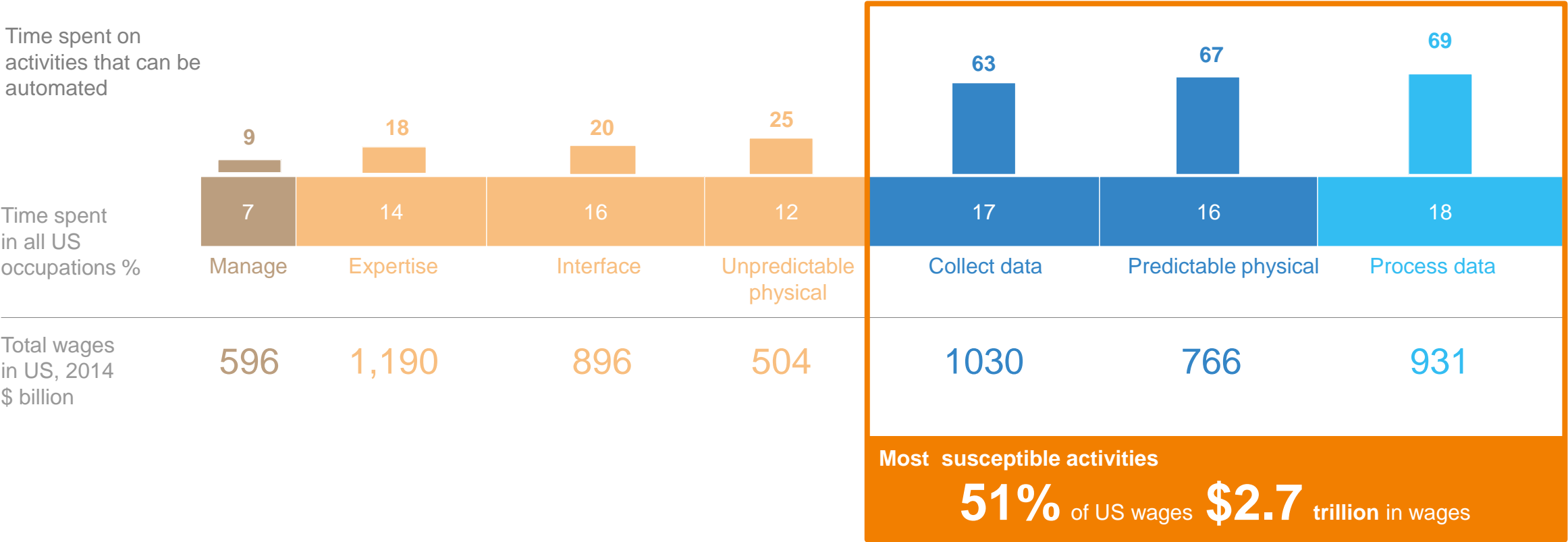


Category	Capability	Level	Capability	Level
Sensory perception	Sensory perception	Medium	Recognizing known patterns/ categories (supervised learning)	High
Social and emotional	Social and emotional sensing	Low	Generating novel patterns/ categories	Low
	Social and emotional reasoning	Low	Logical reasoning/problem solving	Low
	Emotional and social output	Low	Optimization and planning	High
Physical	Fine motor skills/dexterity	Medium	Creativity	Low
	Gross motor skills	High	Information retrieval	High
	Navigation	High	Coordination with multiple agents	Low
	Mobility	Low	Output articulation/presentation	Medium
			Natural language generation	Medium
			Natural language understanding	Low

<sup>1</sup> Assumes technical capabilities demonstrated in commercial products, R&D, and academic settings

# Some activities have higher technical automation potential

Automation potential across activity categories based on currently demonstrated technologies






# Automation will impact all sectors, some more than others

BASED ON CURRENTLY  
DEMONSTRATED TECHNOLOGIES

## Sector density of most automatable activities





Highest density of automatable activities

-  Accommodation and food services
-  Manufacturing
-  Transportation and warehousing
-  Agriculture
-  Retail trade

53–73%



Lowest density of automatable activities

-  Health care and social assistance
-  Professionals
-  Management
-  Educational services

27–39%



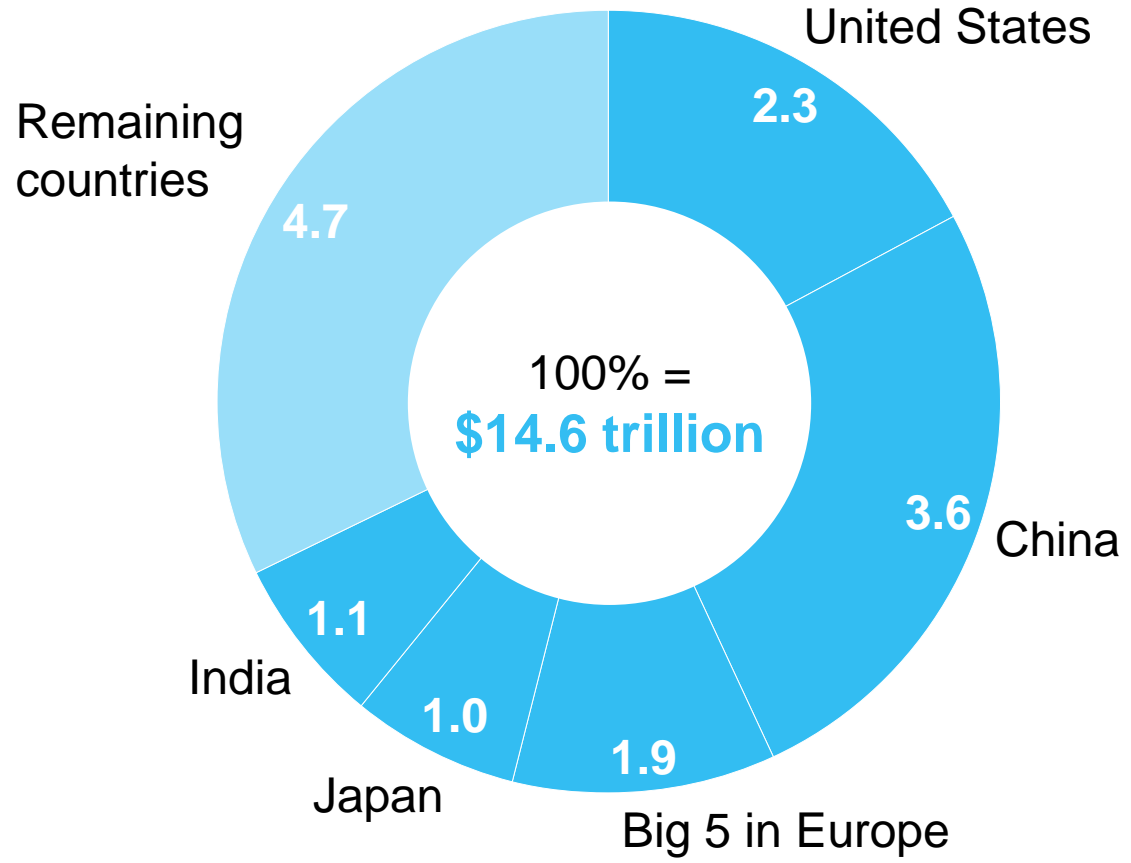
# Automation will impact all economies

Automation potential across 46 countries

BASED ON CURRENTLY DEMONSTRATED TECHNOLOGIES

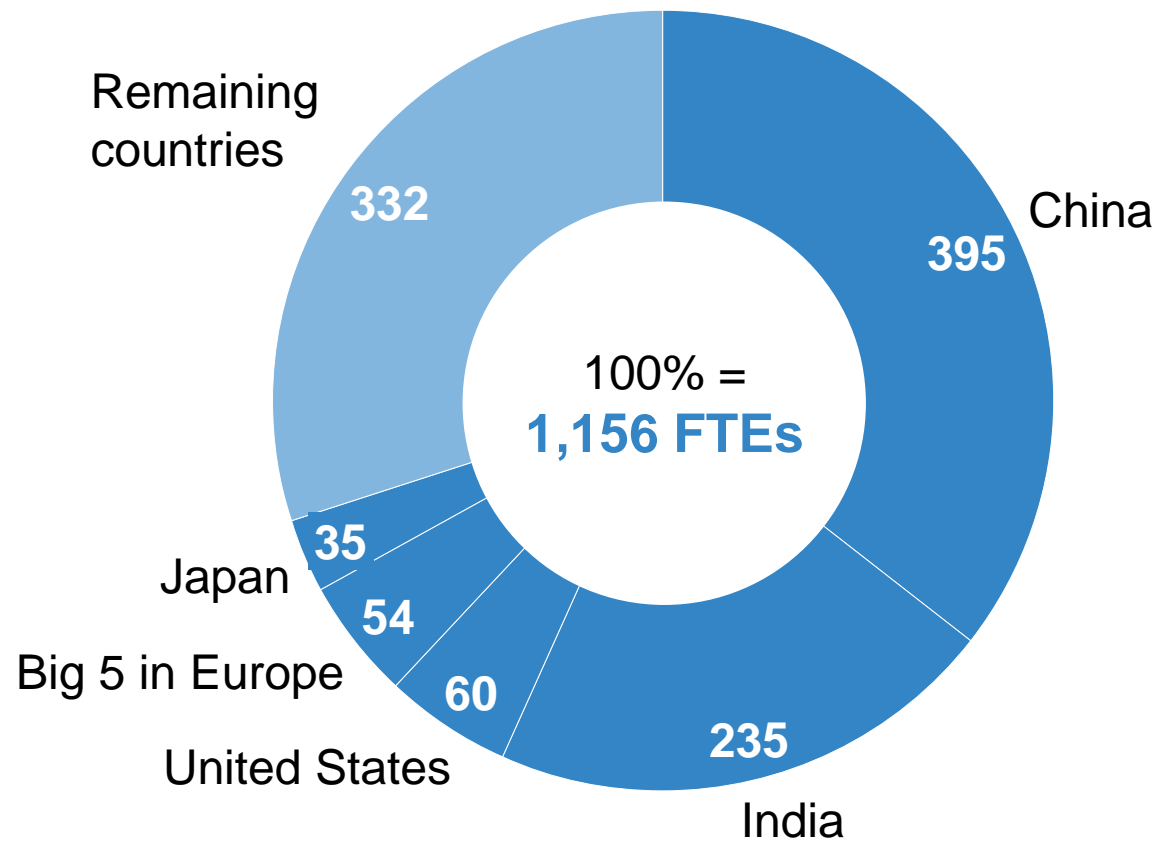
## Wages associated with technically automatable activities

\$ trillion

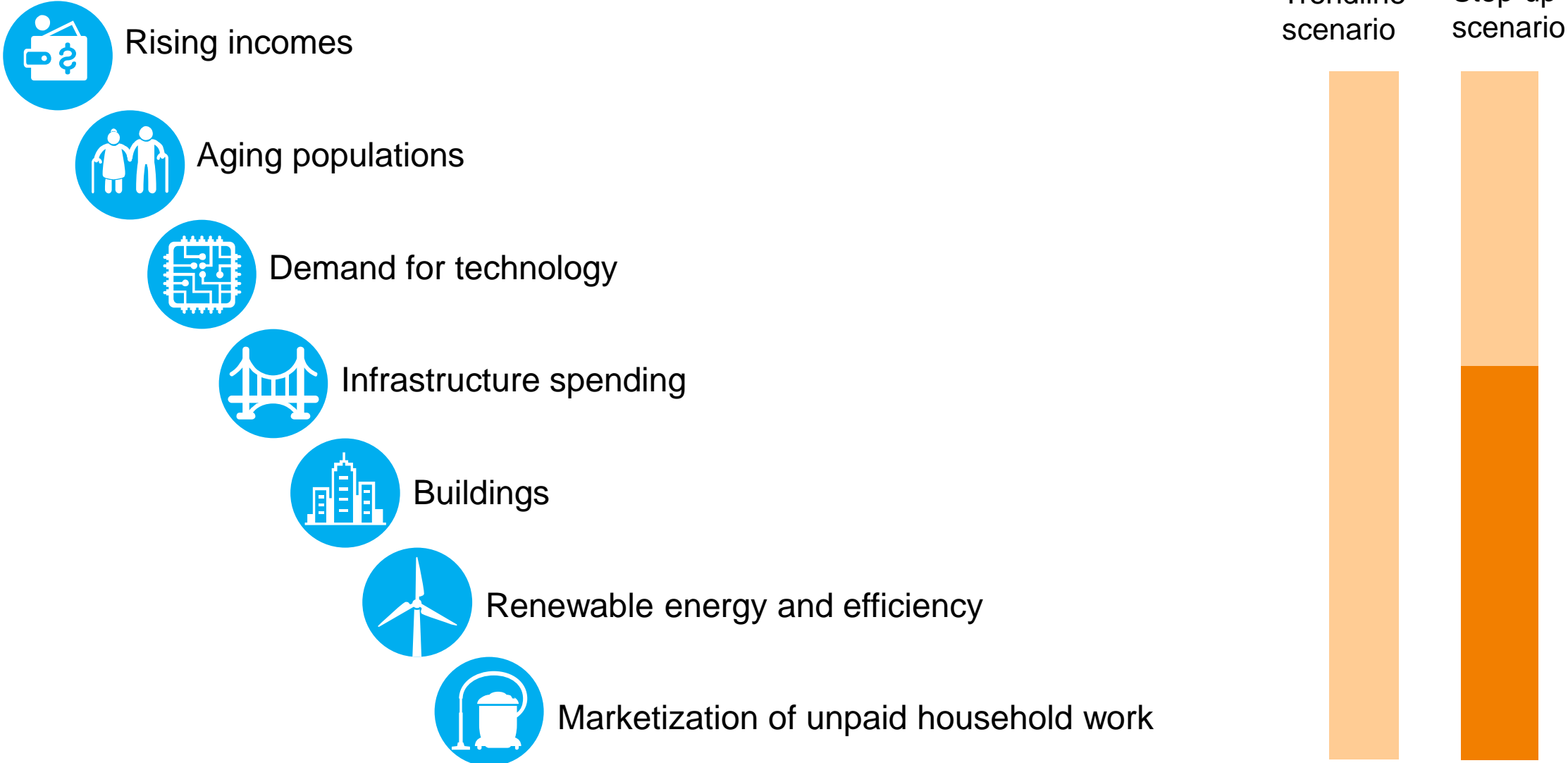


## Labor associated with technically automatable activities

Million FTE



# We model seven catalysts of labor demand in two scenarios

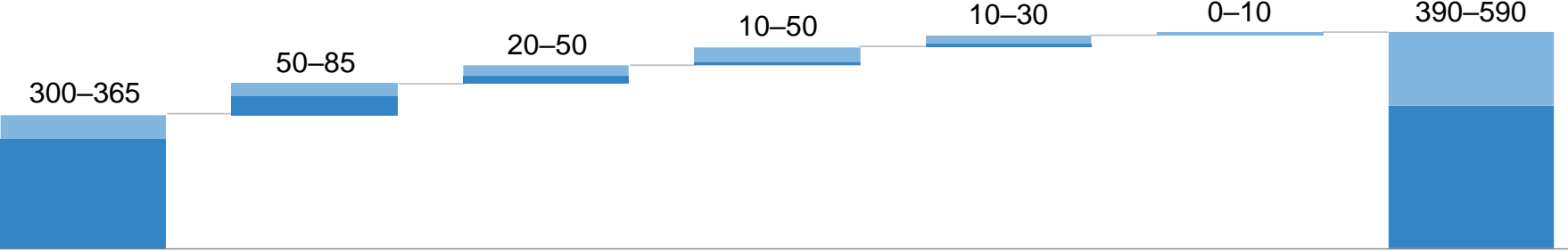


# Seven catalysts of labor demand will could create millions of new jobs

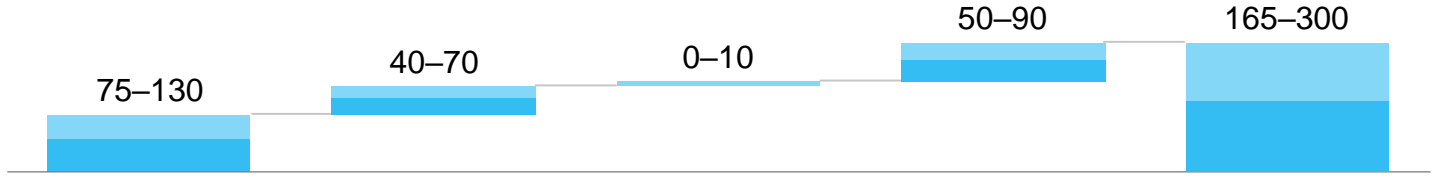
Million FTEs, midpoint automation scenario, 2015-2030

- High
- Low
- Step-up scenario
- Trendline scenario

## Trendline scenario

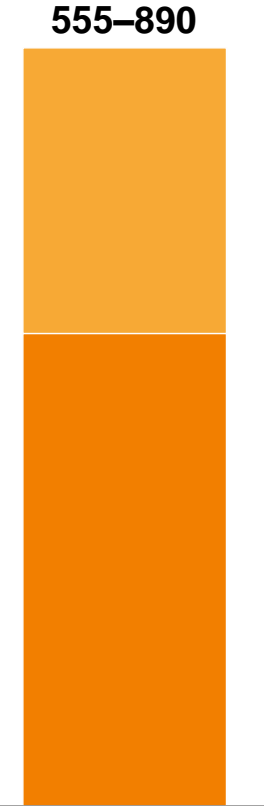


Rising incomes Aging health care Investment: technology Investment: real estate construction Investment: infrastructure Energy transitions and efficiency Trendline scenario total



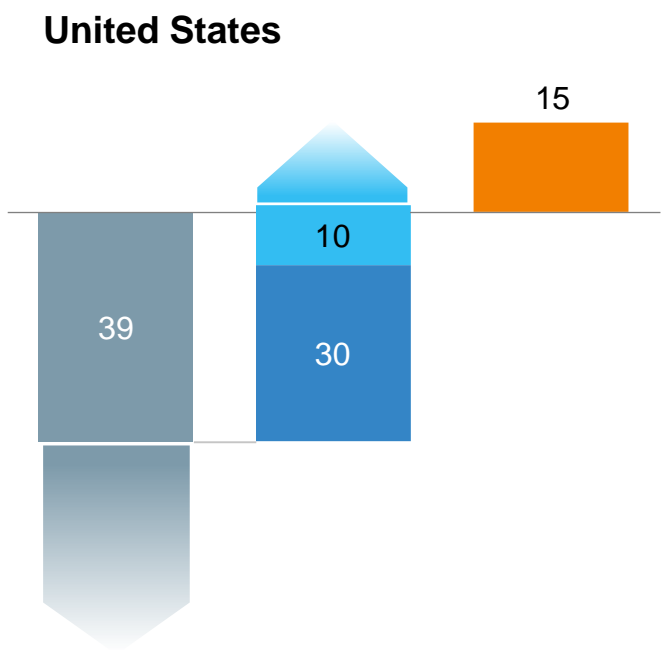
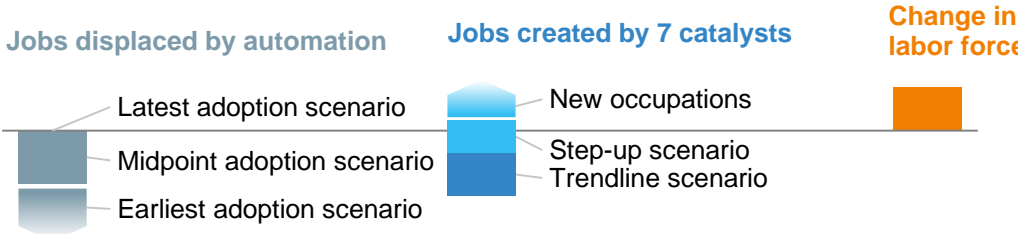
Added investment: real estate construction Added investment: infrastructure Added investment: energy transitions and efficiency Marketization of unpaid work Step-up scenario total

## Overall total

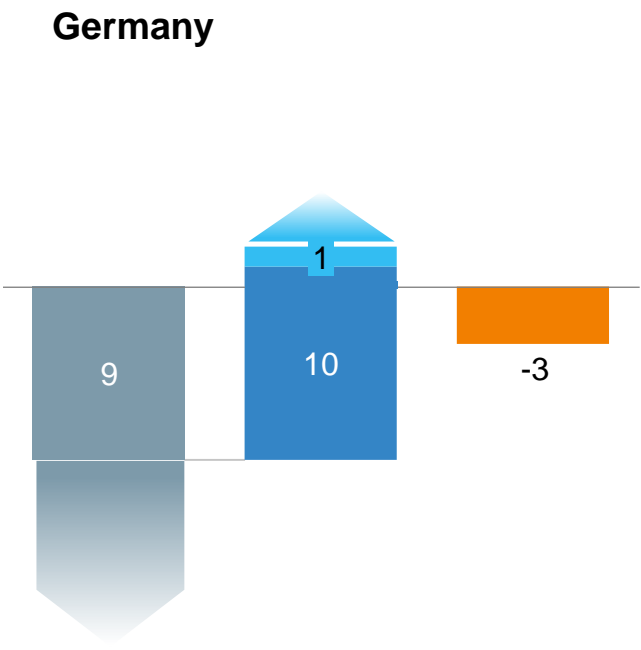


# New jobs created by the seven catalysts will offset automation in most scenarios

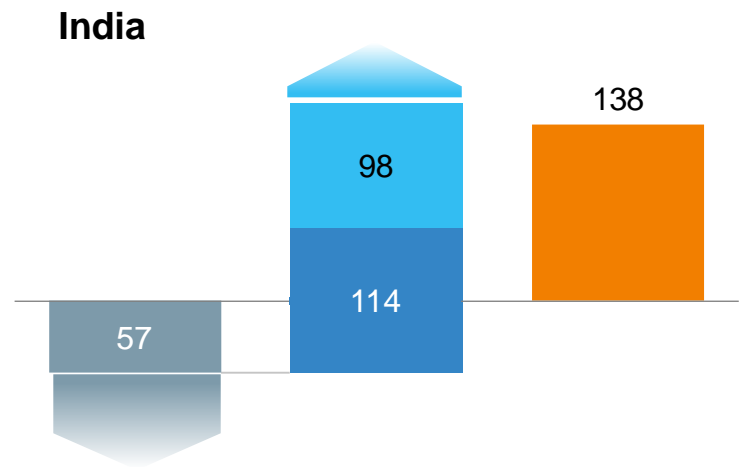
Jobs displaced by automation, jobs created by seven catalysts, labor force growth  
Millions, 2016-2030



Enough jobs created in the **step-up scenario** (with new occupations) to offset automation and labor force growth



Enough jobs created in the **trendline scenario** to offset automation and the decline in the labor force



Enough jobs are created in the **step-up scenario** to offset both automation and the growth in labor force



# Four key transitions for work and workers

- 1 Occupation mix will shift** as some occupations grow and others likely decline
- 2 Skills demand will shift** from physical labor and basic cognitive to higher cognitive, social and emotional, and technological skills
- 3 Workplaces and workflows will need to be redesigned** as humans work more closely with increasingly capable machines
- 4 Potential pressure on wages**, due to occupational mix shift and partial automation

# Jobs of the future: Many occupations will see growing demand....

Net impact of automation and seven catalysts of labor demand, 2016–30

% change (+/-), step-up labor demand, midpoint automation

**Occupation groups**

% of labor force across 6 focus countries

**Care providers**  
1-9%



Doctors  
Nurses, physicians assistants, and pharmacists  
Care workers  
Community and social workers

**Educators**  
1-5%



School teachers  
Education support workers

**Managers and executives**  
2-5%



Executives  
Managers

**Professionals**  
2-19%



Account managers  
Engineers  
Scientists and academics  
Legal support workers

**Technology professionals**  
0-2%



Computer engineers  
Computer specialists

**Builders**  
5-11%



Architects, surveyors, and cartographers  
Construction workers  
Crane and tower operators

**Creatives**  
0-1%



Artists and designers  
Entertainers/media workers

United States Germany Japan China Mexico India

% change in FTEs

- -35 or less
- -25 to -34
- -15 to -24
- -5 to -14
- Within ±5
- 5 to 24
- 25 to 49
- 50 to 99
- 100 or more

Country	United States	Germany	Japan	China	Mexico	India
Doctors	5 to 24	5 to 24	Within ±5	25 to 49	5 to 24	100 or more
Nurses, physicians assistants, and pharmacists	25 to 49	25 to 49	Within ±5	100 or more	25 to 49	100 or more
Care workers	100 or more	25 to 49	Within ±5	100 or more	25 to 49	100 or more
Community and social workers	-5 to -14	-5 to -14	-5 to -14	25 to 49	5 to 24	25 to 49
School teachers	5 to 24	25 to 49	Within ±5	100 or more	5 to 24	100 or more
Education support workers	5 to 24	-5 to -14	-15 to -24	100 or more	25 to 49	100 or more
Executives	5 to 24	5 to 24	Within ±5	25 to 49	5 to 24	25 to 49
Managers	5 to 24	5 to 24	Within ±5	25 to 49	5 to 24	25 to 49
Account managers	Within ±5	5 to 24	Within ±5	5 to 24	5 to 24	5 to 24
Engineers	5 to 24	5 to 24	Within ±5	5 to 24	25 to 49	25 to 49
Scientists and academics	Within ±5	5 to 24	Within ±5	5 to 24	25 to 49	25 to 49
Legal support workers	-5 to -14	Within ±5	-5 to -14	5 to 24	5 to 24	Within ±5
Computer engineers	25 to 49	25 to 49	5 to 24	25 to 49	25 to 49	100 or more
Computer specialists	5 to 24	25 to 49	Within ±5	25 to 49	5 to 24	25 to 49
Architects, surveyors, and cartographers	5 to 24	25 to 49	Within ±5	5 to 24	25 to 49	25 to 49
Construction workers	25 to 49	5 to 24	-15 to -24	5 to 24	25 to 49	100 or more
Crane and tower operators	-15 to -24	-15 to -24	-25 to -34	-5 to -14	25 to 49	25 to 49
Artists and designers	5 to 24	25 to 49	Within ±5	25 to 49	5 to 24	25 to 49
Entertainers/media workers	Within ±5	5 to 24	Within ±5	100 or more	5 to 24	25 to 49

# ....while other occupations may decline

Net impact of automation and seven catalysts of labor demand, 2016–30

% change (+/-), step-up labor demand, midpoint automation<sup>1</sup>

## Occupation groups

% of labor force across  
6 focus countries

**Customer interaction**  
10–25%



**Office support**  
3–18%



**Other jobs, predictable environments**  
15–29%



**Other jobs, unpredictable environments**  
9–42%



## Example occupational categories<sup>3</sup>

United States    Germany    Japan    China    Mexico    India

% change  
In FTEs

- -35 or less
- -25 to -34
- -15 to -24
- -5 to -14
- Within ±5
- 5 to 24
- 25 to 49
- 50 to 99
- 100 or more

Occupation Group	Example Occupational Category	United States	Germany	Japan	China	Mexico	India
Customer interaction	Personal care workers	5 to 24	5 to 24	Within ±5	100 or more	5 to 24	100 or more
	Food serving workers (hosts)	-5 to -14	5 to 24	-5 to -14	50 to 99	5 to 24	100 or more
	Sales workers (retail and online)	Within ±5	5 to 24	-5 to -14	5 to 24	5 to 24	5 to 24
	Hotel and travel workers	-25 to -34	-5 to -14	-5 to -14	50 to 99	-5 to -14	5 to 24
Office support	Computer support workers	-5 to -14	5 to 24	-5 to -14	5 to 24	-5 to -14	50 to 99
	Financial workers (procurement, payroll, etc.)	-25 to -34	-25 to -34	-25 to -34	5 to 24	5 to 24	5 to 24
	Administrative assistants	-5 to -14	-5 to -14	-5 to -14	5 to 24	50 to 99	50 to 99
Other jobs, predictable environments	Production workers	-25 to -34	-5 to -14	-35 or less	Within ±5	50 to 99	50 to 99
	Material moving machine operators	-25 to -34	-25 to -34	-35 or less	-5 to -14	5 to 24	5 to 24
	Agricultural graders and equipment operators	-25 to -34	-25 to -34	-35 or less	-5 to -14	-5 to -14	-5 to -14
	Food preparation workers	-35 or less	Within ±5	-25 to -34	50 to 99	Within ±5	5 to 24
	General mechanics	-25 to -34	-25 to -34	-25 to -34	Within ±5	Within ±5	5 to 24
Other jobs, unpredictable environments	Specialized mechanics and repair	Within ±5	5 to 24	Within ±5	50 to 99	50 to 99	100 or more
	Emergency first responders	-5 to -14	-5 to -14	-5 to -14	50 to 99	Within ±5	5 to 24
	Machinery installation and repair workers	-5 to -14	-5 to -14	-25 to -34	Within ±5	5 to 24	50 to 99
	Agricultural field workers	5 to 24	-5 to -14	-5 to -14	Within ±5	Within ±5	-5 to -14
	Building and grounds cleaners	5 to 24	5 to 24	5 to 24	50 to 99	50 to 99	50 to 99

# Between 75 million and 375 million workers globally may need to move

Number of workers needing to move out of current occupational categories to find work, 2016–30 (trendline scenario)<sup>1</sup>

Million (1 block = ~5 million)

■ Additional from earliest adoption scenario
 ■ Midpoint automation scenario

*2030 workforce (% transitioning)*

## 16–54



**United States**  
166 million  
*(up to 32%)*

## 11–27



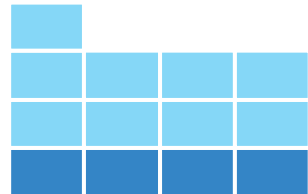
**Japan**  
59 million  
*(up to 46%)*

## 3–12



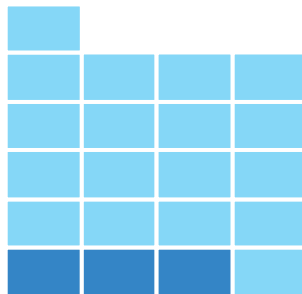
**Germany**  
37 million  
*(up to 33%)*

## 17–64



**Other advanced**  
195 million  
*(up to 33%)*

## 12–102



**China**  
757 million  
*(up to 13%)*

## 3–38



**India**  
612 million  
*(up to 6%)*

## 1–7



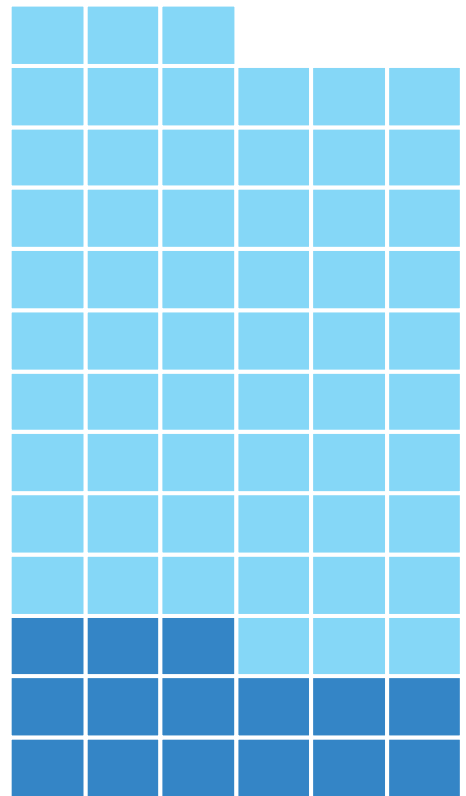
**Mexico**  
68 million  
*(up to 10%)*

## 10–72



**Other developing**  
767 million  
*(up to 9%)*

## 75–375



**Global**  
2,661 million  
*(up to 14%)*

# New jobs require more education than those that are automated

Net change in total employment by education required, 2016–30

■ Trendline scenario  
■ Step up scenario

**United States**

Education level	Projected net change to labor demand Millions	% change in jobs Trendline to step-up
Less than secondary	-2.8 to -2.3	-14 to -12
Secondary	-7.0 to -1.1	-12 to -2
Associate	-1.7 to 0.9	-5 to -2
College	1.8 to 3.3	+6 to +12
Advanced	0.8 to 1.0	+9 to +11

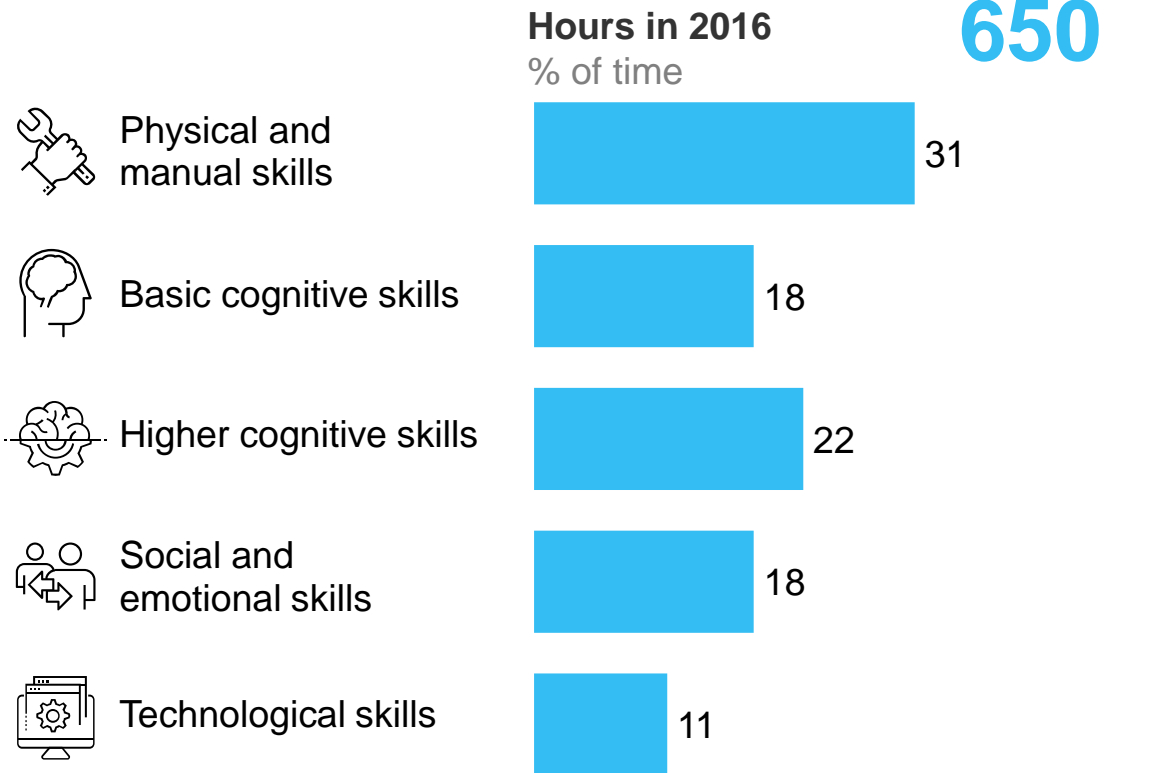
**India**

Less than secondary	3.6 to 17	+2 to +8
Secondary	34 to 100	+11 to +32
Associate	12.6 to 25.6	+22 to +46
College	6.5 to 9.3	+38 to +54
Advanced	4.0 to 4.3	+73 to +79

# Demand will grow for more technological, social and emotional skills...

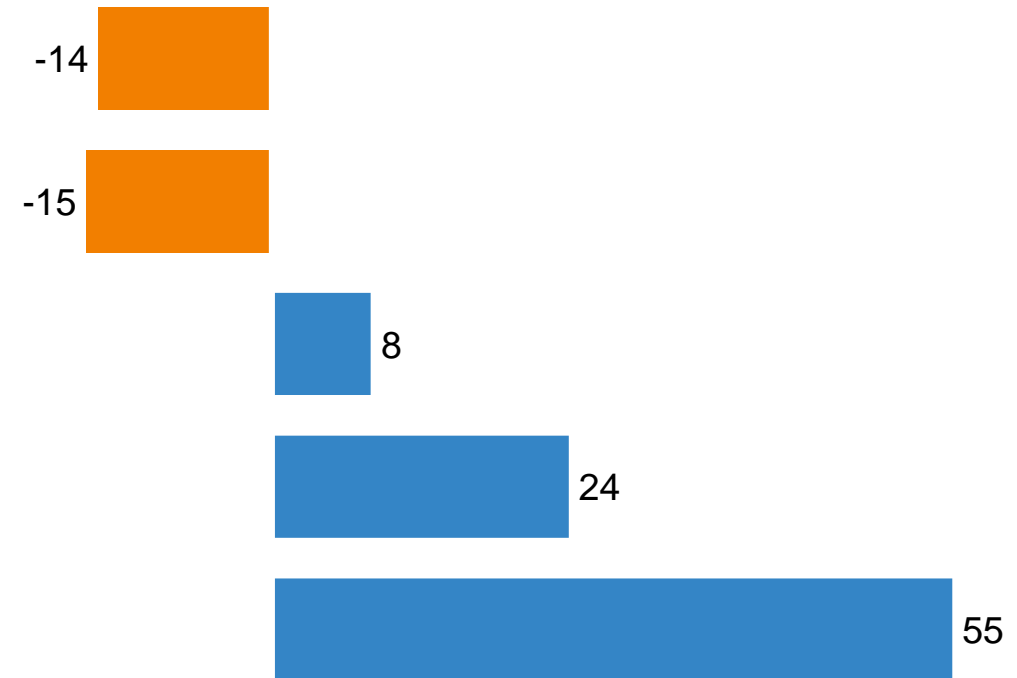
All sectors

Large portion time spent today in physical and basic cognitive skills...



...but in the future, time spent on these skills is going to decrease while skills such as tech, social and emotional will grow

**Change in number of hours**  
2016-30, %





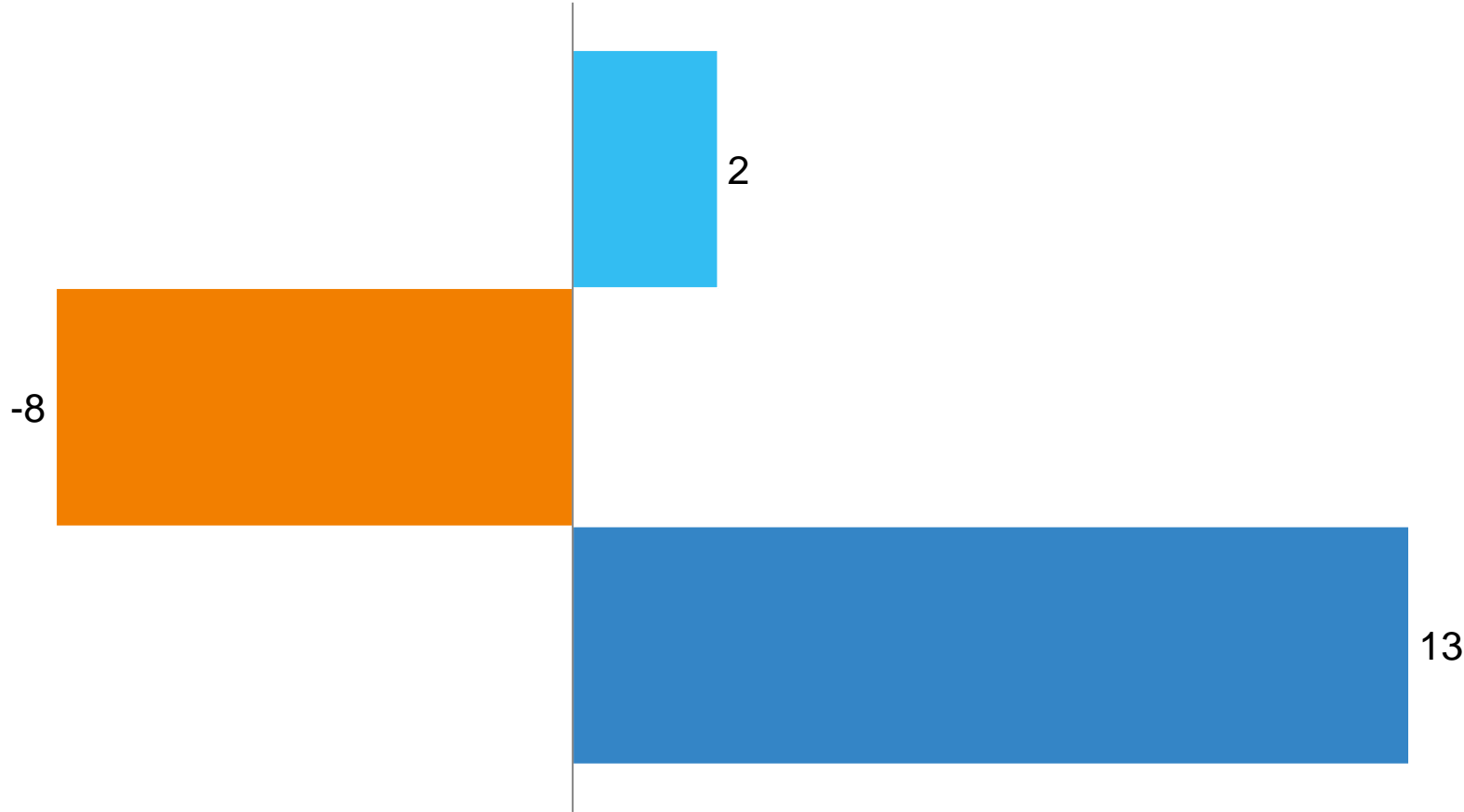
# What about wages?

Middle-wage jobs may fare well in emerging economies but lose out in advanced economies

- 0–30th
- 31st–70th
- 71st–100th

Net job change by wage tercile, %  $\pm$  change from 2030 labor supply due to automation and labor demand catalysts

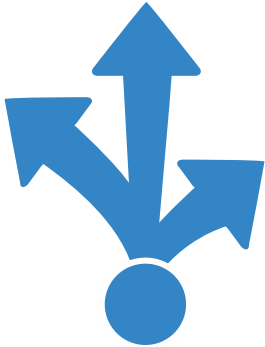
## United States



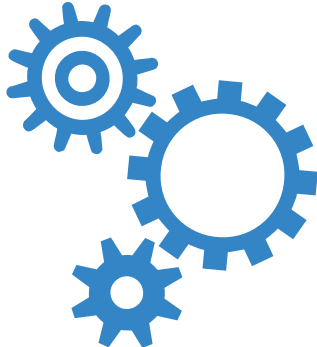
**Wage impacts driven by:**

- Occupation mix shift
- Wage structure for different skills
- Other factors incl. skill (and un-skill) bias technical change
- Labor supply-demand dynamics

# Several factors affect the pace and extent of automation



Technical automation feasibility and pace of breakthroughs



Cost of developing and deploying technologies (incl replacement)



Cost of labor and related supply-demand dynamics (incl quality, quality, wages)



Benefits including and beyond labor substitution



Regulatory and social factors







# Some priorities to shape the future



## Strengthen demand

unlock investment,  
revive entrepreneurship  
and economic growth



## Invest in human capital

education, training  
and life-long learning



## Reinvigorate labor market dynamism

and enable more  
diverse forms of work

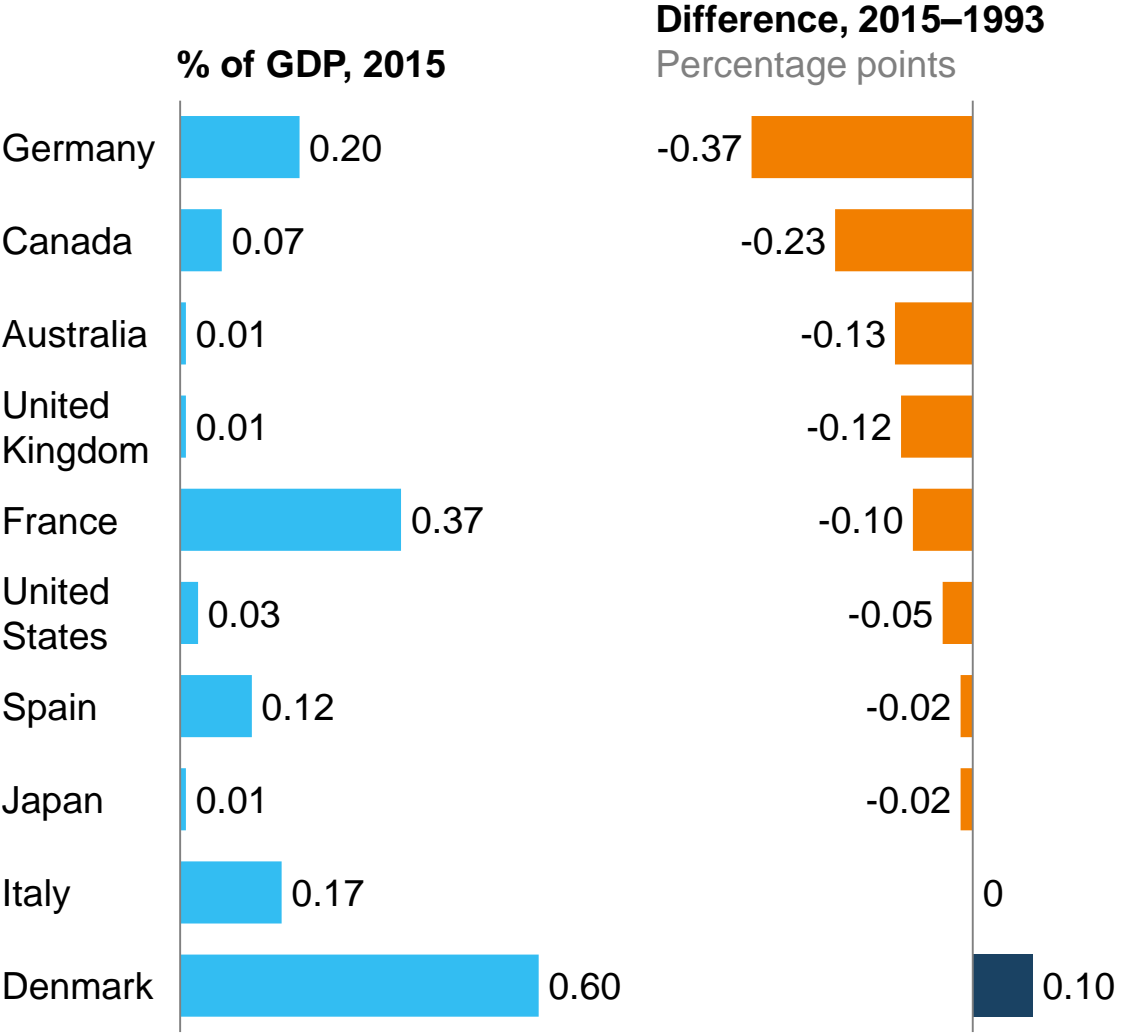


## Rethink transition support

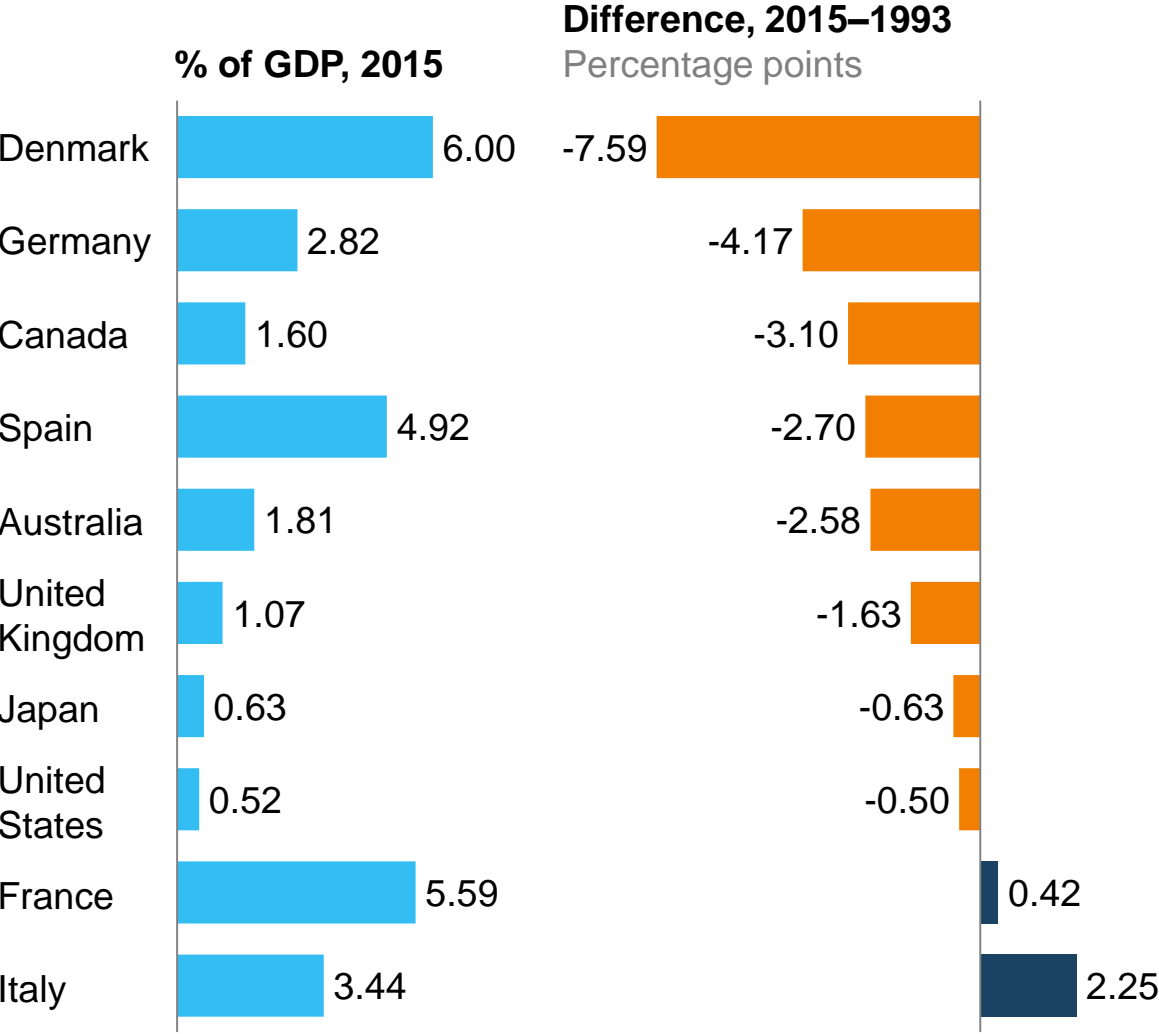
for all workers

# Investment in training and labor markets has been declining

**Total public spending on worker training**

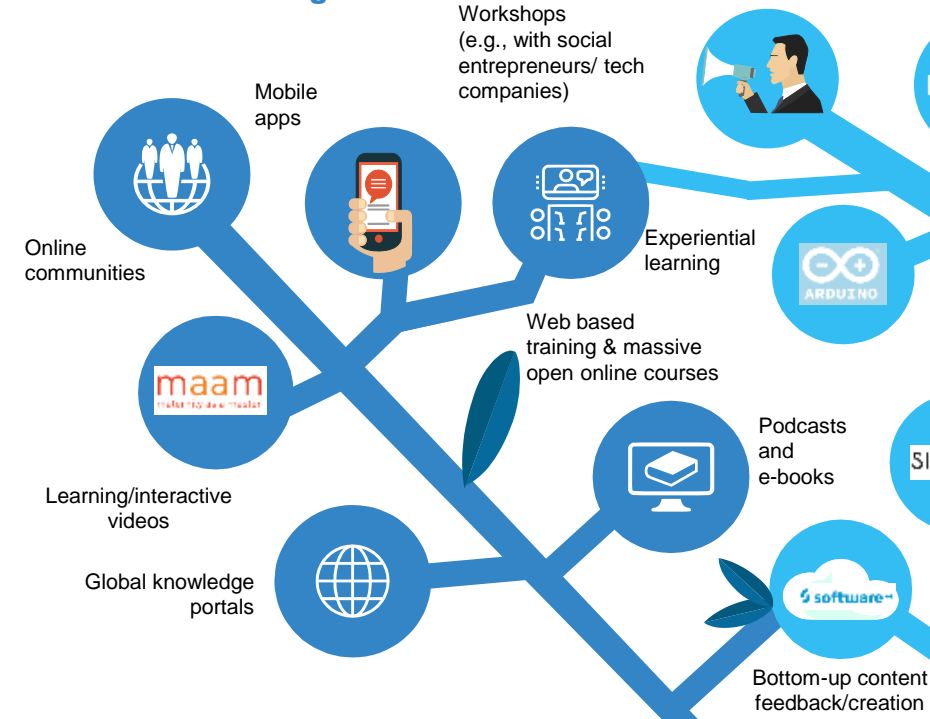


**Total public spending on labor markets**

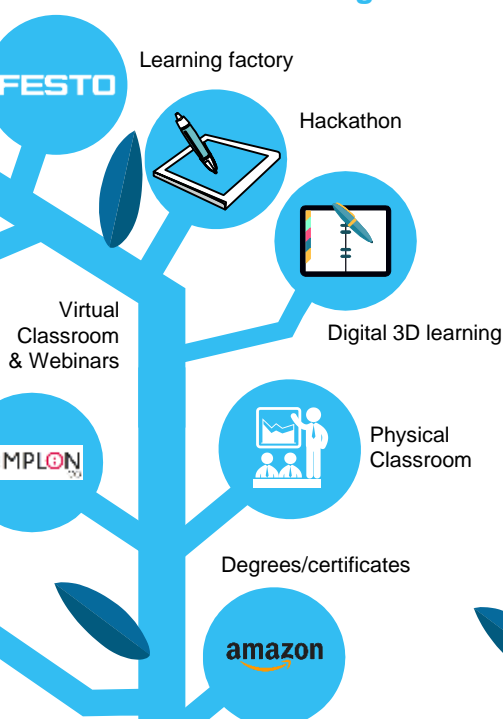


# Reskilling goes beyond the classroom

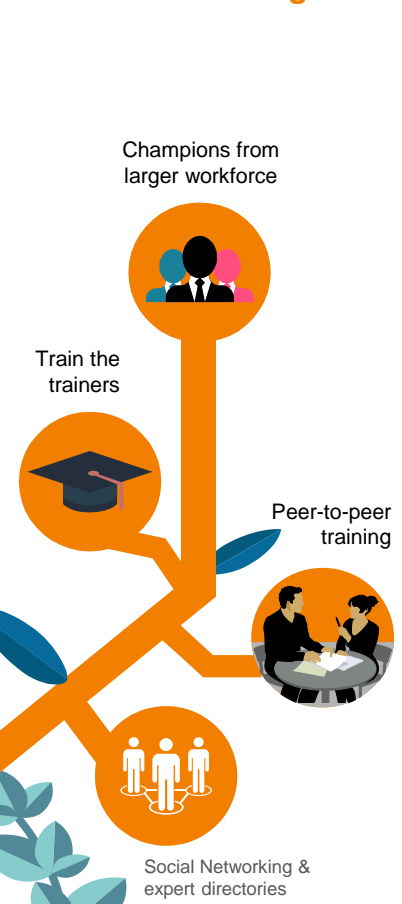
## On-demand learning



## Planned learning



## Social learning



Re-skilling programs

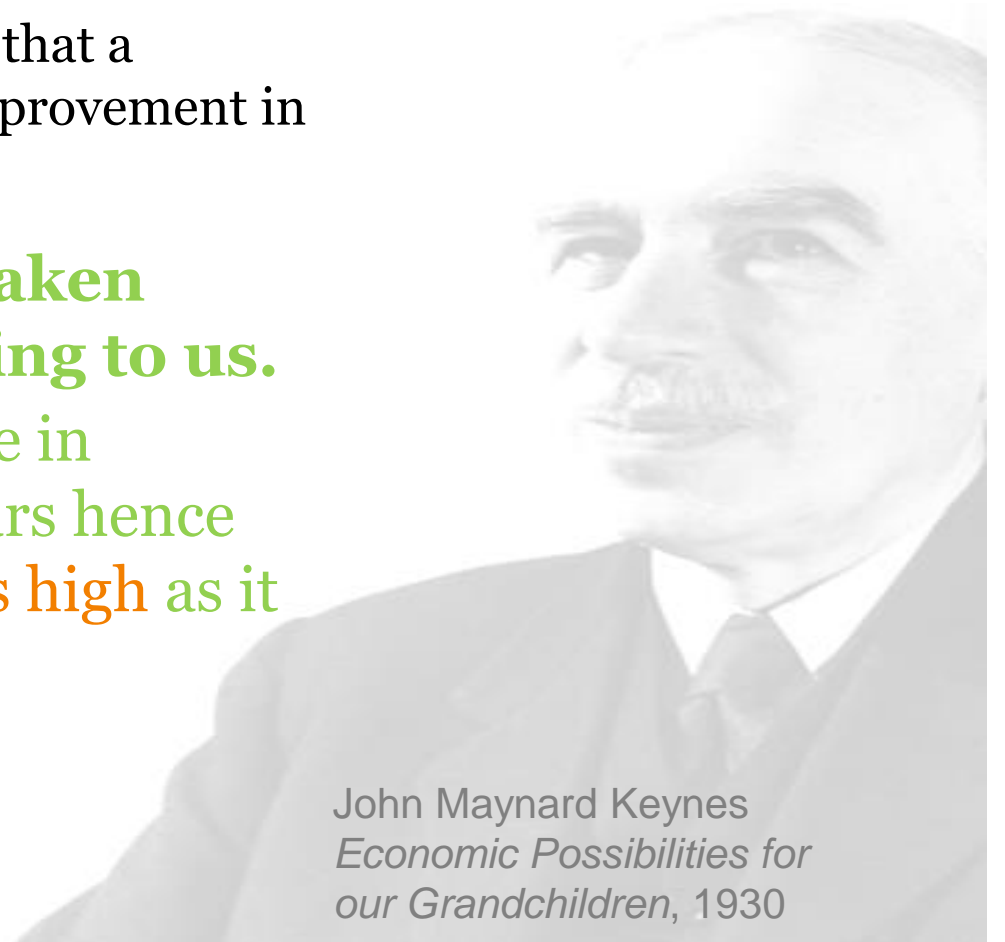




We are suffering just now from a bad attack of economic pessimism. It is common to hear people say that the era of enormous economic progress which characterised the last century is over; that the rapid improvement in the standard of life is now going to slow down ... ; that a decline in prosperity is more likely than an improvement in the decade which lies ahead of us.

**I believe that this is a wildly mistaken interpretation of what is happening to us.**

I would predict that the standard of life in progressive countries one hundred years hence will be between **four and eight times as high** as it is today.



John Maynard Keynes  
*Economic Possibilities for  
our Grandchildren, 1930*

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EHELF | June 2019

