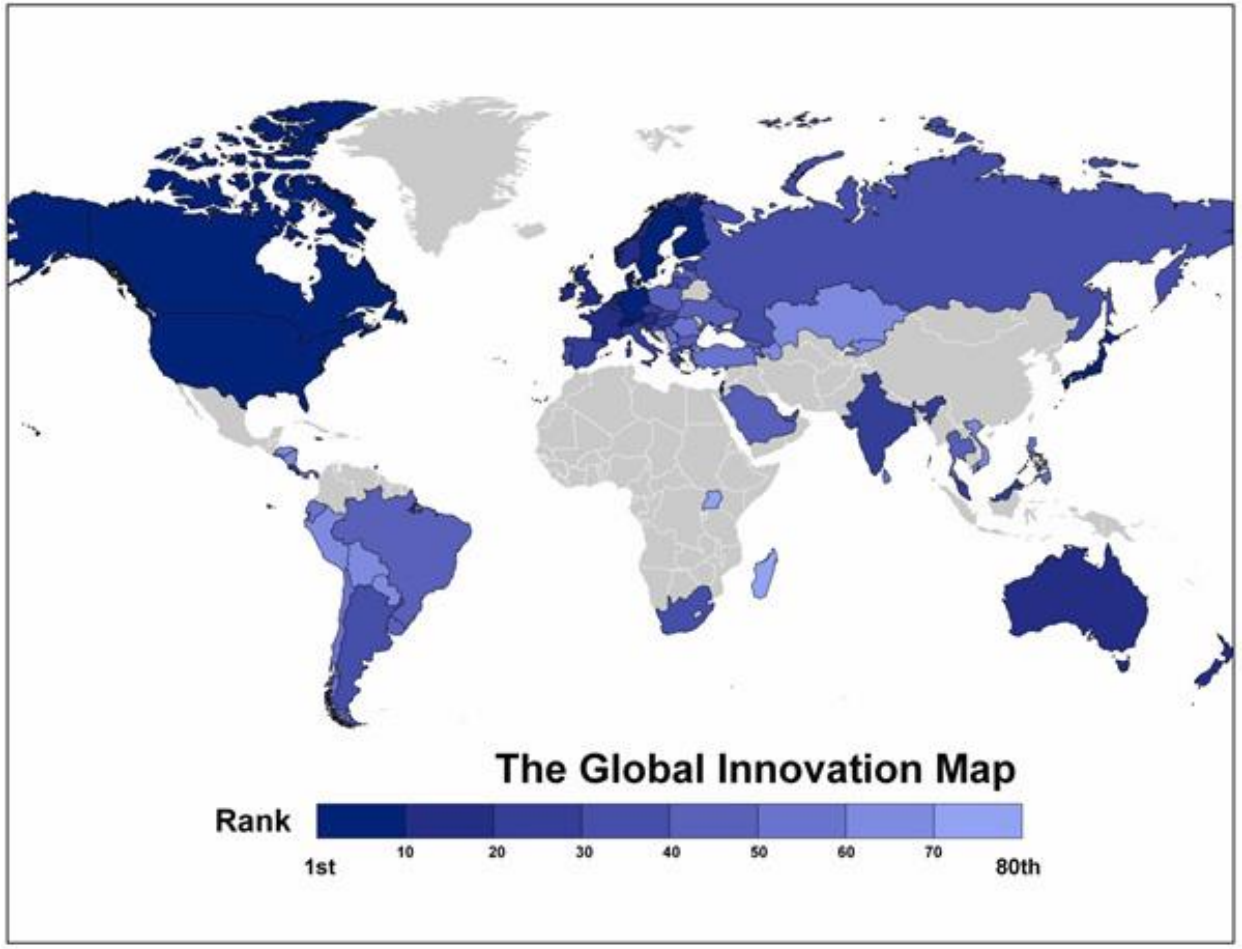
PLAUSIBLE SCENARIOS:
DEVELOPMENT, DISSEMINATION AND ADOPTION OF AUTOMATION TECHNOLOGIES
PRODUCTION BASE OF DEVELOPED AND DEVELOPING COUNTRIES

Countries that generate technological change: Production and Dissemination of leading technologies

- A few advanced economies are generating almost all leading technological change and their intensification across the range of practical sciences
- These advanced countries are heading the rest of the world to the adoption and implementation of most cutting-edge innovations
- The majority of this technological change is related to digitalization, robotisation and streamlining production and services
- The driving reason is economic: competition in terms of
  - Performance: better quality, reliability, speed, agility, memory, interconnectedness
  - Capability: multi-tasks and reach
  - Energy and material efficiency
  - Synergy: combining and recombining ideas and technologies and generating new products and services
- Even within the advanced countries, the dissemination of these practices is very irregular and often controversial



Technological change: Production base indifferent countries

- China alone is producing more patents than the USA and might catch-up in some leading technologies, for example robotics and AI
- Nonetheless, the great majority of disruptive, global-impact digitalisation and robotisation, still happens in developed countries
- Hardly the most developing countries can be innovators of technology: copying “Silicon Valley” has proven to be impossible anywhere
- The educational standards of the workforce in developing countries leave them poorly equipped to absorb innovations from the rest of the world
- Technological progress will be disseminated from outside.They will have to
  - adopt and adapt it
  - minimize its negative effects on cometitiveness, unemployment and inequality, but
  - take advantage of its enormous potential: the modern sectors will benefit more and faster
- Countries in transition are more likely to exploit the advantages and "leapfrogging" technologies, but they are also more vulnerable to their dangers
- If in rich countries technological change can be increasingly disruptive, it can be catastrophic in emerging countries

A18 Patent applications for the top 25 offices and origins, 2014

Origin	Office																							
	Australia	Brazil	Canada	China	China, Hong Kong SAR	European Patent Office	France	Germany	India	Indonesia	Iran (Islamic Republic of)	Israel	Italy	Japan	Malaysia	Mexico	New Zealand	Republic of Korea	Russian Federation	Singapore	South Africa	Thailand	Turkey	United Kingdom	United States of America
Australia	1,988	210	441	664	156	792	10	29	276	98		55	5	452	97	138	813	210	87		215	3	5	101	3,516
Austria	196	261	207	944	63	1,966	22	1,044	244	41		8	4	419	61	107	42	317	207	169	108	1	3	41	2,402
Belgium	270	312	302	657	98	1,922	102	52	288	53		3	5	458	39	126	72	233	190	60	88			199	2,513
Brazil	48	4,659	74	137	4	208	4	13	55	8		5	2	88	8	88	8	58	22	28	29		2	6	810
Canada	510	290	4,198	1,009	219	1,730	23	63	354	64		69	4	635	49	230	120	404	160	94	124		4	228	12,963
China	593	559	604	801,135	1,052	4,657	170	524	880	248		54	8	2,531	244	264	103	1,572	598	327	336	37	35	293	18,040
Denmark	253	263	323	847	92	1,982	5	20	374	85		17	1	416	65	177	71	170	171	39	93			80	2,216
Finland	193	225	323	1,165	100	2,196	13	72	295	83		16		385	40	90	36	331	212	86	103		4	166	3,102
France	839	1,810	1,743	4,575	325	10,616	14,500	238	1,492	275		93	28	3,452	243	600	154	2,210	1,140	353	390	8	10	177	11,947
Germany	1,457	2,780	2,362	13,597	898	25,672	528	48,154	3,174	474		52	187	6,615	375	1,347	317	4,232	2,120	543	715	12	28	516	30,193
India	207	122	159	267	37	543	2	32	12,040	67		18	1	228	57	84	82	127	59	102	156	10	8	36	7,127
Iran (Islamic Republic of)						3	1	1	2	2	13,683				1									4	63
Israel	328	222	380	656	103	1,047	4	26	305	16		1,125	1	528	8	110	64	266	150	103	82		4	98	7,352
Italy	326	703	552	1,361	199	3,642	55	107	619	110		17	8,601	757	65	268	66	424	490	84	154	2	8	36	4,764
Japan	1,682	2,229	1,847	40,460	1,382	22,111	167	5,338	5,338	2,382		207	166	265,959	1,481	943	227	15,653	1,646	1,424	235	648	44	491	86,691
Netherlands	630	1,412	581	2,924	146	6,856	37	127	1,286	369		32	9	2,239	188	573	123	750	1,064	171	210	1		201	4,927
Republic of Korea	595	430	352	11,528	125	6,162	39	1,384	860	236		40	6	5,682	160	240	37	164,073	472	146	104	25	23	101	36,744
Russian Federation	29	34	52	130	16	208	4	33	81	11		25	2	71	6	14	8	41	24,072	9	7	3	6	10	1,007
Spain	123	265	214	340	76	1,463	80	28	181	39		24	11	242	35	218	46	136	129	47	112	1	6	41	1,640
Sweden	461	617	480	2,020	130	3,868	64	326	913	115		51	46	1,038	93	198	103	681	503	83	123	2	3	159	4,928
Switzerland	1,083	1,408	1,380	3,338	907	6,854	248	814	1,549	411		14	85	2,454	423	1,003	374	1,322		550	219	1	2	313	4,906
Thailand	12	5	5	22	4	19	2	2	18	17		1	1	51	15	3	1	12	3	6	1	6,973		13	155
Turkey	12	17	10	84	2	404	5	10	19	5		3	1	47	3	7	2	24	20	2	4		4,766	5	306
United Kingdom	1,153	808	1,172	2,050	404	4,726	42	234	1,094	200		133	15	1,731	298	321	289	920	451	356	395	4	4	15,196	13,157
United States of America	11,551	9,617	16,361	33,963	4,930	36,686	232	6,056	9,824	1,475		2,458	46	25,998	1,823	7,270	2,600	13,982	4,383	3,645	2,330	110	95	2,778	285,096
Others/Unknown	1,417	1,084	1,359	4,304	1,074	6,329	174	1,238	1,293	1,139	119	1,753	147	3,513	1,743	1,716	1,970	2,144	1,959	1,885	1,219	89	37	1,751	32,237
Total	**25,956**	**30,342**	**35,481**	**928,177**	**12,542**	**152,662**	**16,533**	**65,965**	**42,854**	**8,023**	**13,802**	**6,273**	**9,382**	**325,989**	**7,620**	**16,135**	**7,728**	**210,292**	**40,308**	**10,312**	**7,552**	**7,930**	**5,097**	**23,040**	**578,802**

Note: Origin data are based on absolute counts, not equivalent counts.

Source: WIPO Statistics Database, October 2015.

Main divide regarding plausible future scenarios of accelerating-automation technologies

Rational optimists:

Beyond threats and fears,

- artificial intelligence, robotics, and the wide range of automation technologies, will contribute to an unimaginable increase in social wellbeing
- Humanity will enter an era of abundance when:
  - famine, poverty, disease, ignorance, environmental collapse and even war will be overcome
- Accelerating technological change will create more jobs within unimaginably-creative occupations
- Technological deflation, increasing availability of goods and services, and schemes like minimum guaranteed income will compensate for job losses in the transition phase

Rational pessimists:

Despite expected benefits of transformational technologies:

- the inescapable ignorance and
- the inherent lack of control over its effects and true potential

can evolve into unpredictable situations:

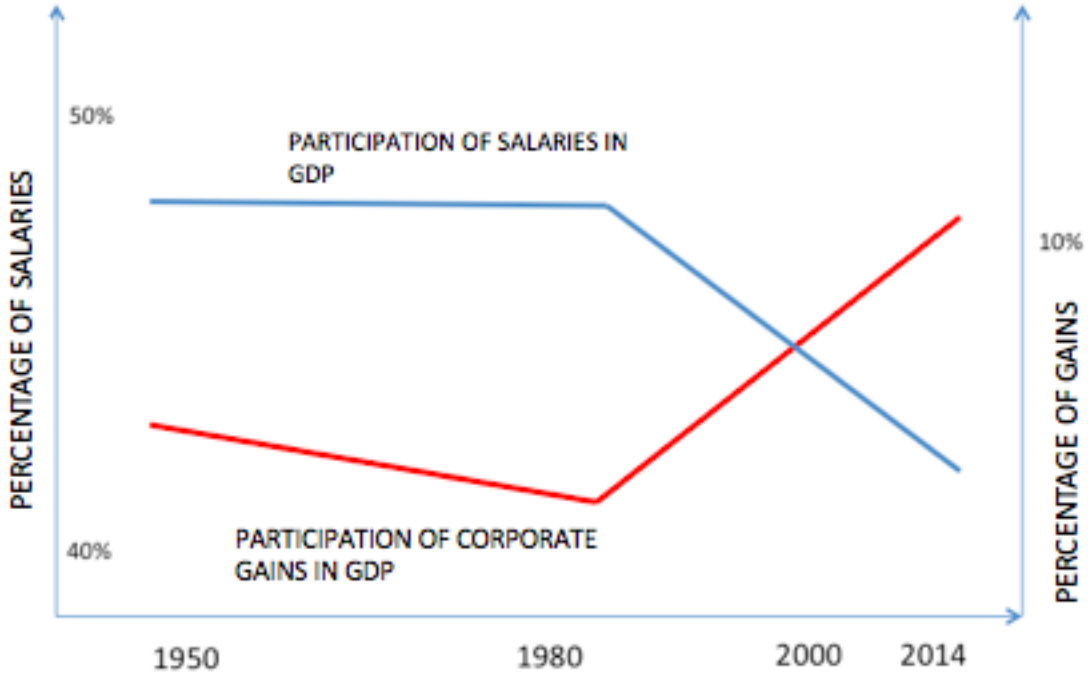
- Out-of-control socio-economic dynamics
- Only few social groups, corporations and individuals benefit within certain countries
- Totalitarianism, transhuman aristocracy
- "vicious cycles" that make negative effects more extreme and permanent:
  - economic inequality, unemployment, concentration of wealth and power in fewer hands
  - catastrophic scenarios

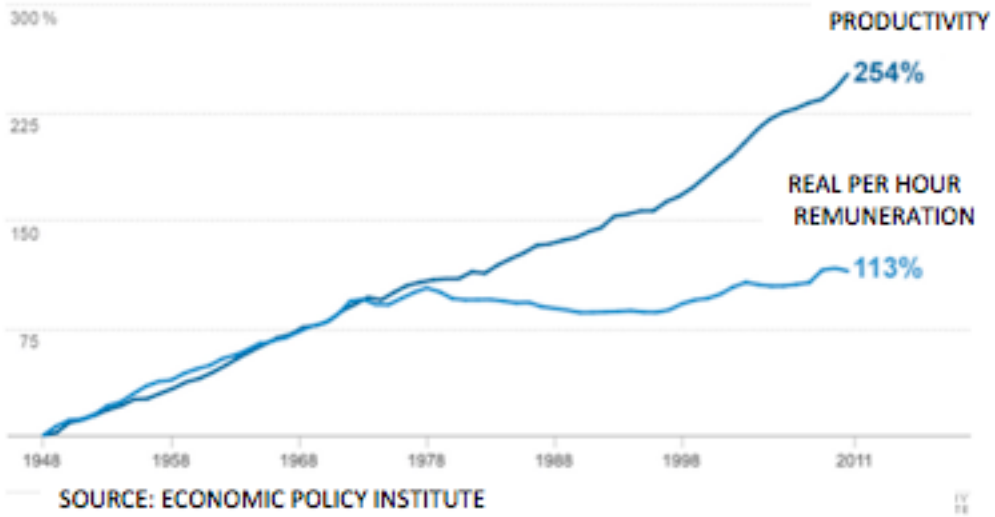
Consensus:

- these scenarios will impact developed as well as developing countries in different ways and speeds
- in advanced countries the dissemination of these practices is very irregular, often controversial and hugely disruptive
- there is very little research on how and when developing countries may be affected
- developing countries are likely to be more exposed to its challenges
- there is little that is understood about future disruptive effects, like technological unemployment and deflation

HOW TECHNOLOGICAL CHANGE IMPACTS EMPLOYMENT
INNOVATION AND TECHNOLOGICAL UNEMPLOYMENT:
EMERGING AUTOMATION TECHNOLOGIES
IMPACT ON COUNTRIES AT DIFFERENT STAGES OF DEVELOPMENt

Perceived Trends: Growing Gap between Productivity and Global Labour Remuneration





- Accelerating technological progress has not lead to an increase in labour productivity,
- It has fallen from 4% per year in the 1970s to 2% in the 1980s and to only 1% in this century
- This is worse in developing countries
- In most developing countries only modern sectors see an increase in labour productivity, although these employ ever fewer employees and workers
- This means that the share of wages in GDP relative to corporate profits is reduced

The gap between remuneration per hour and productivity has been growing globally since 1980

- Case: a greater portion of what US companies produce go to their owners (stockholders) and creditors; only a smaller portion goes to labour (Brookings Institute

- Robotization accelerates in the face of rising wages and salaries, the aging of populations, the lower cost of software and increasingly malleable hardware, and the explosion of new applications of all genres and sizes, although for the moment it has been concentrated in transportation, electronics and precision manufacturing equipment
- In the medium term, this outstrips existing technological powers, such as Korea, Germany, China, Japan and the United States, which will gain in competitiveness due to robotization, in contrast to the advantages of lower labour costs

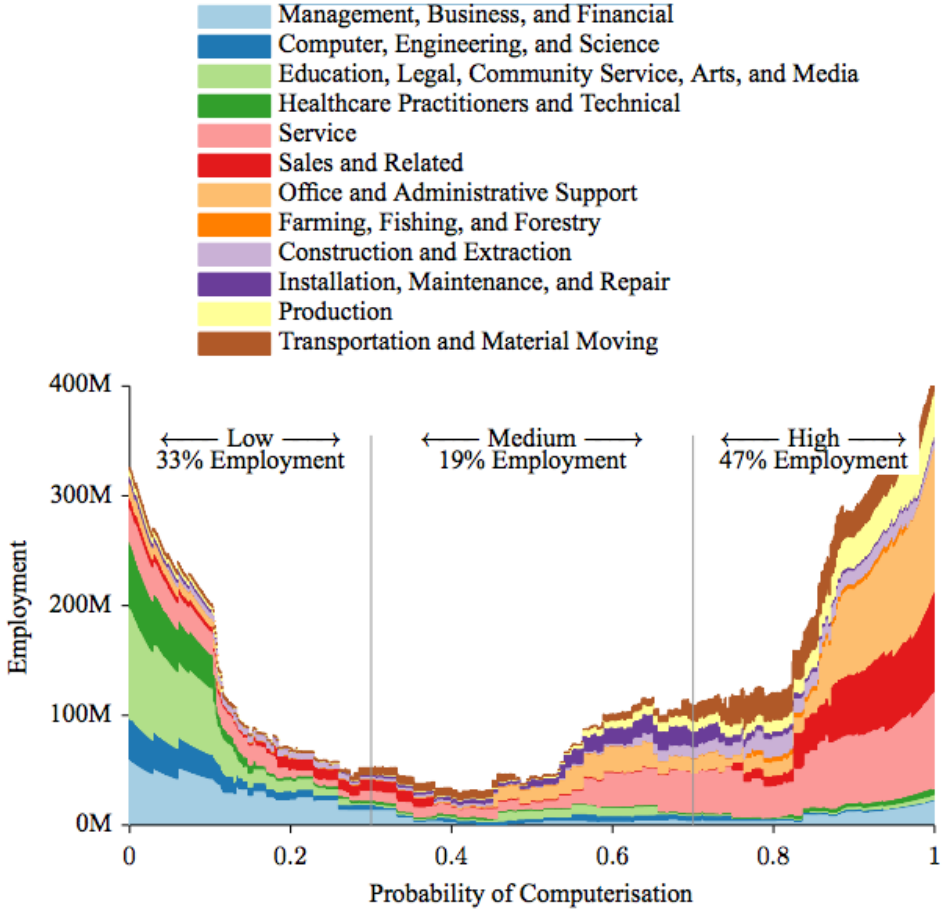
Susceptibility of Jobs lost to Automation

A study from the Oxford Martin School concludes that in the next 10 to 20 years, almost half of occupations in developed countries will be replaced by computerization and robotization:

Examples: marketing, transportation, logistical, production, office, administrative support, general services and low educational and technical jobs

Although this study does not go deep into the issue of automation in the developing world, other studies rightly point out that this transformation is not economically viable in the medium term due to the abundance of cheap labour and resources:

- Labour-saving inventions can only be adopted if access to cheap labour becomes scarce
- However, as the cost of automation drops and low-skilled labour cannot adjust, job displacement can occur almost suddenly and exponentially, sector by sector
- This may be more disruptive in countries with low consumer demand and limited social safety nets
- Hence the importance of
  - empowering the education sector, radically changing the academic curriculum
  - fostering an increase in labour productivity
  - rapidly moving towards an Entrepreneurial State that creates private investment opportunities and boosts innovation and entrepreneurship
  - Establishing cheap or free Internet for all may be a first step

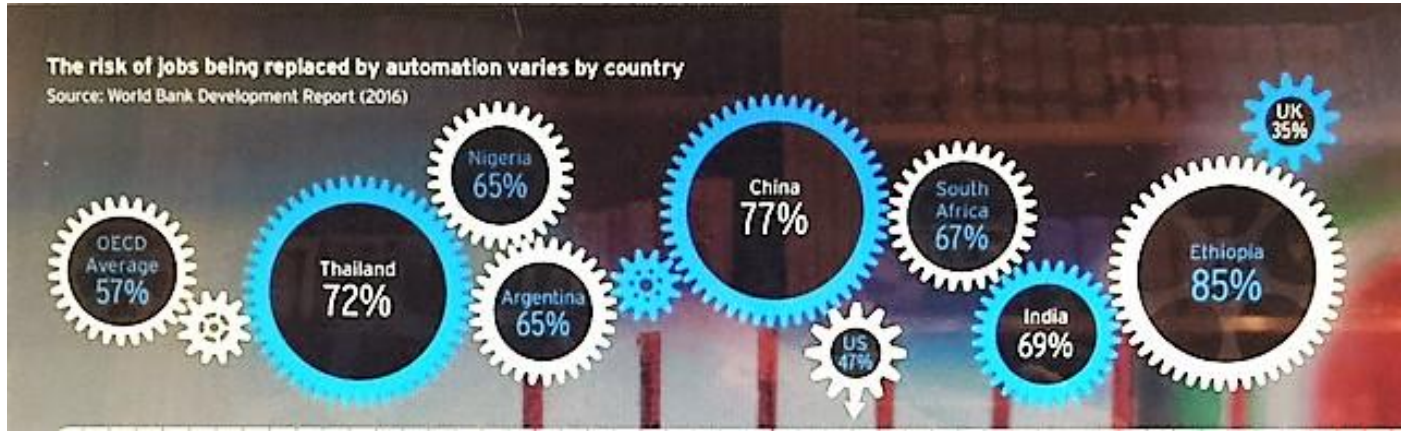


Carl Frey Benedikt and Michael A. Osborne, "The Future of Employment: How Susceptible are Jobs to Computerisation?" Universidad de Oxford, 2013

FIGURE III. The distribution of BLS 2010 occupational employment over the probability of computerisation, along with the share in low, medium and high probability categories. Note that the total area under all curves is equal to total US employment.

Risk of Job Displacement by Automation

- While emerging economies have become better at adopting new technologies, they have increasingly deteriorated in their widespread diffusion, and in strategically identifying the best applications and competent use. This has induced further social and economic divergences
- The lack of progress in accelerating penetration rates, and hence in elevating the productivity of the informal sectors, particularly of small and medium size industries, is the reason for more than 80 percent of the increase in income inequality and partly explains the de-industrialization of emerging economies
- Many countries defended themselves by promoting an export economy based on raw materials and semi-industrial goods or “maquilas”,
- But automation now forces them to export services, the viability of which is increasingly sensitive to growing automation: 47% in USA, 57% in OECD countries, 69% in India, 77% in China and 85% in Ethiopia (see **TECHNOLOGY AT WORK v2.0: The Future Is Not What It Used to Be**”, Oxford Martin School, Citi GPS: Global Perspectives & Solutions, Enero de 2016)
- This makes them both more exposed to lower per capita income and increasing inequality
- Innovation itself is not and cannot cause technological unemployment. The market spontaneously rewards more productive, cost-effective, cheaper-to-replicate solutions
- Digitalisation and robotisation are and may continue to achieve these types of solutions ever faster and cheaper. Innovation policy cannot stop this
- Technological solutions that are more economically viable within the specific institutional and cultural setting of each nation will prevail and replicate



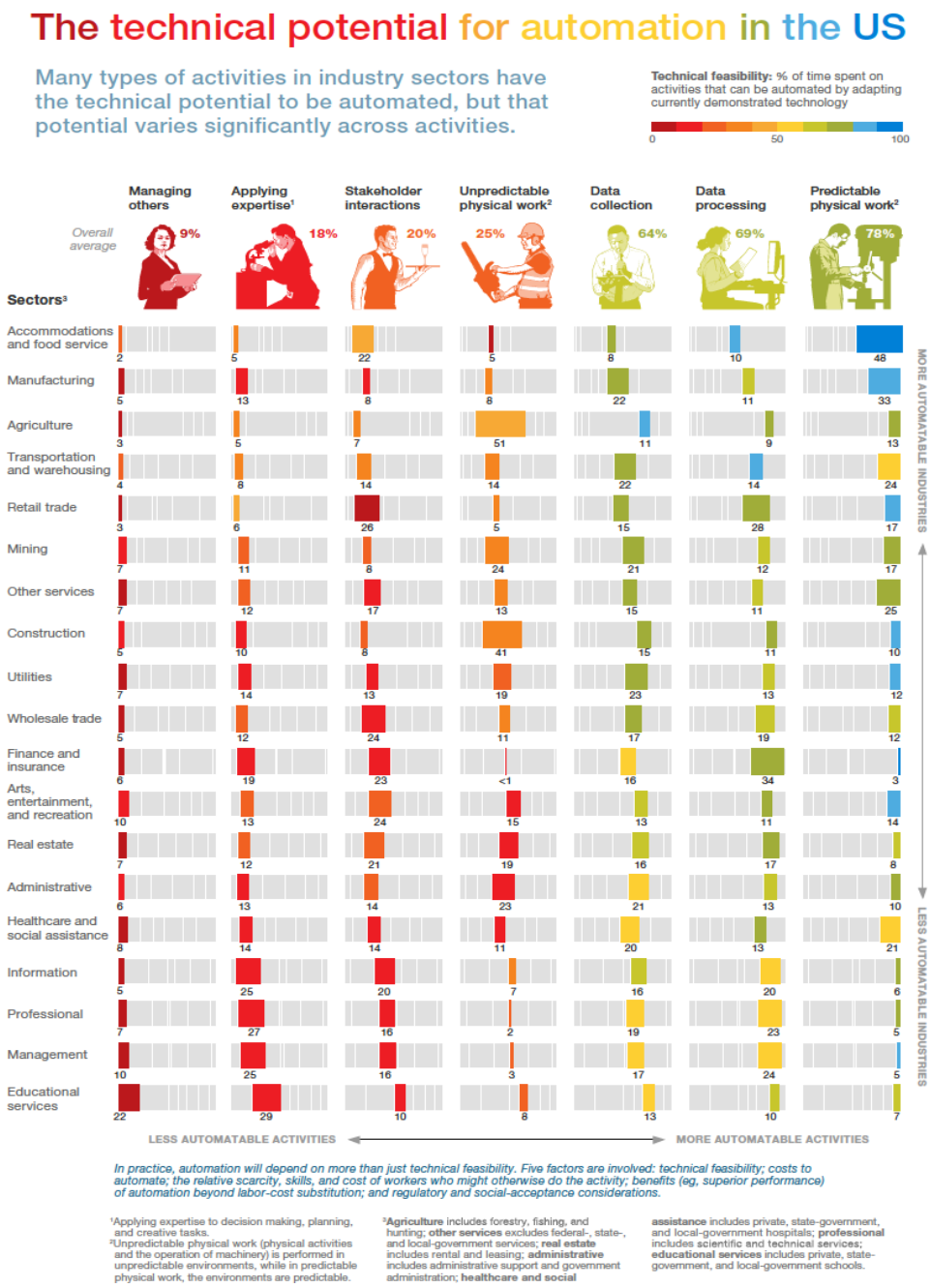


Tableau Public, in McKinsey Quarterly - July 2016

"Where machines could replace humans—and where they can't (yet)"

By Michael Chui, James Manyika, and Mehdi Miremadi

Where machines could replace humans — and where they can't (yet)

McKinsey analyzed the detailed work activities for more than 800 occupations from across the economy to assess the percentage of time spent on activities with the technical potential for automation by adapting currently demonstrated technology. *Use this dashboard to explore the potential for automation in your sector -- click a sector on the left chart below to begin.*

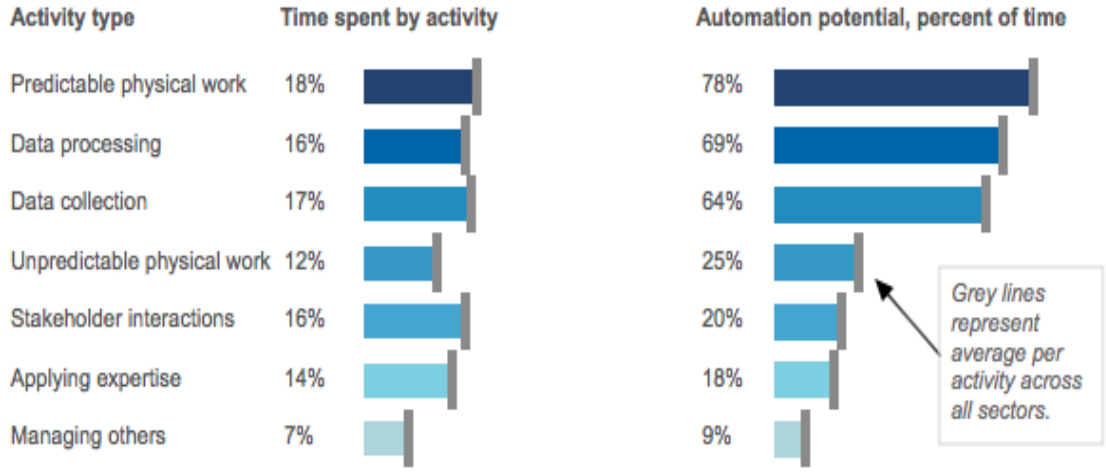
Automation potential by sector

Click a sector to filter the view, click again to remove the filter.

		Percent of time
Goods-producing industries	Manufacturing	59%
	Resource extraction	50%
	Construction	47%
Service-providing industries	Accommodation and food services	73%
	Retail, trade and transportation	51%
	Finance and insurance	43%
	Arts, entertainment, and recreation	41%
	Services - professional and other	39%
	Administrative and government	38%
	Health care and social assistance	36%
	Technology, media, telecom	36%
	Educational services	27%

Work activity summary: *All*

Grey lines represent average per activity across all sectors.



McKinsey&Company

Source: McKinsey Global Institute analysis. For more on this research, see our article : *Where machines could replace humans*

Regions that will probably be most affected by automation

Technological developments are transforming and taking over present and future human occupations, such as:

- The digitization of repetitive and predictable intellectual activities (such as food and accommodation services, graphic design, accounting, legal assistance, medical diagnosis, engineering in general; data research and mining)
- The automation and robotization of semi-manual, repetitive or predictable jobs (handling of heavy machinery, medical surgery, driving of vehicles, construction in general, agro-industrial activities)
- The robotic industry has grown 17% since 2010 and 29% since 2014 and is covering not only industrial production, but services of all kinds: from tourism, to domestic and cleaning activities
- This and increasing digitization may imply that human skills and capabilities might be replaced more and more rapidly

- Since the computer revolution in the 1980s, the labour force absorbed by new technologies has declined from 8.2% to 4.4% in the 1990s and in the last decade to only 0.5%
- Whether these precise percentage-figures are correct or not is irrelevant. What are urgently needed are wide-ranging and deeper studies with greater emphasis on the effects on employment, inequality, the environment and on existential risks under this new era of globalisation

Increasing Inequality in the USA, selected Countries and the World