Automation v Procreation

Hal Varian

Sept 2018

These are the author's personal views and do not necessarily reflect the views of his employer.

~~Automation v Procreation~~

Hal Varian
August 2018

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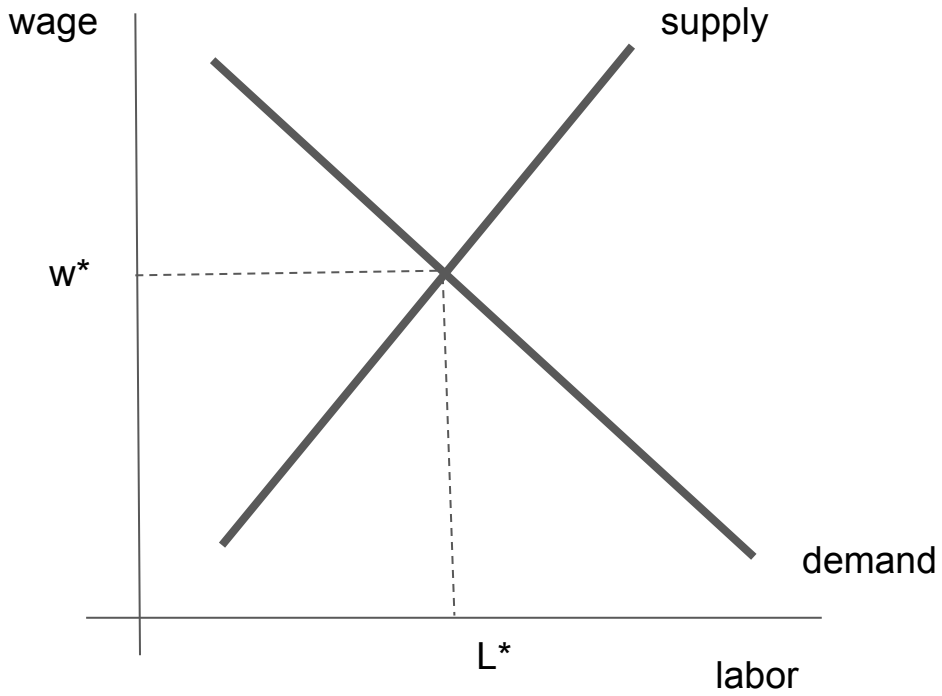


Bots v Tots

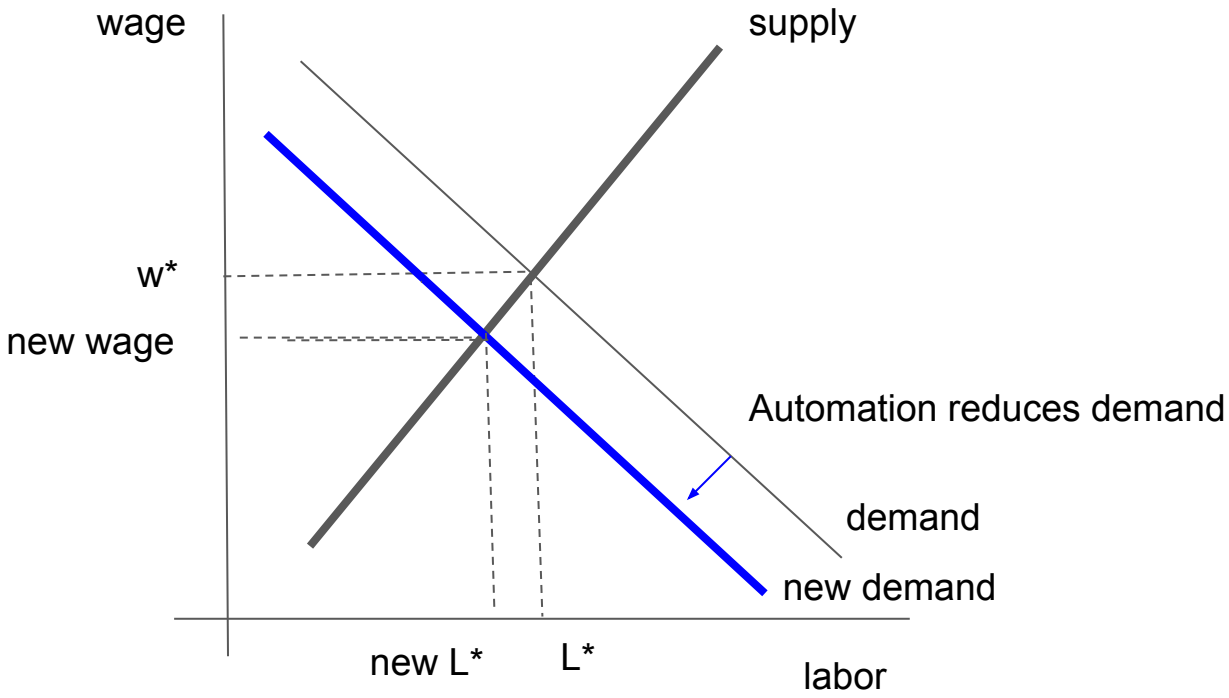


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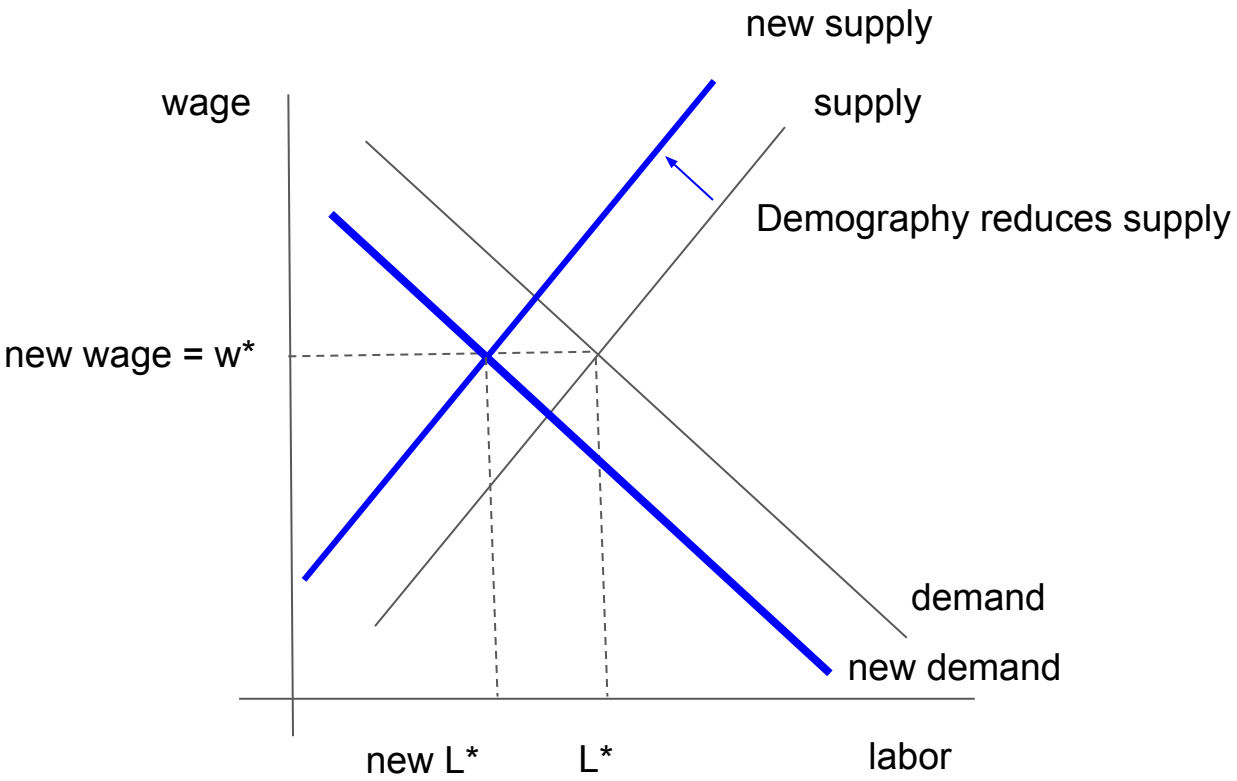
Economics of the labor market



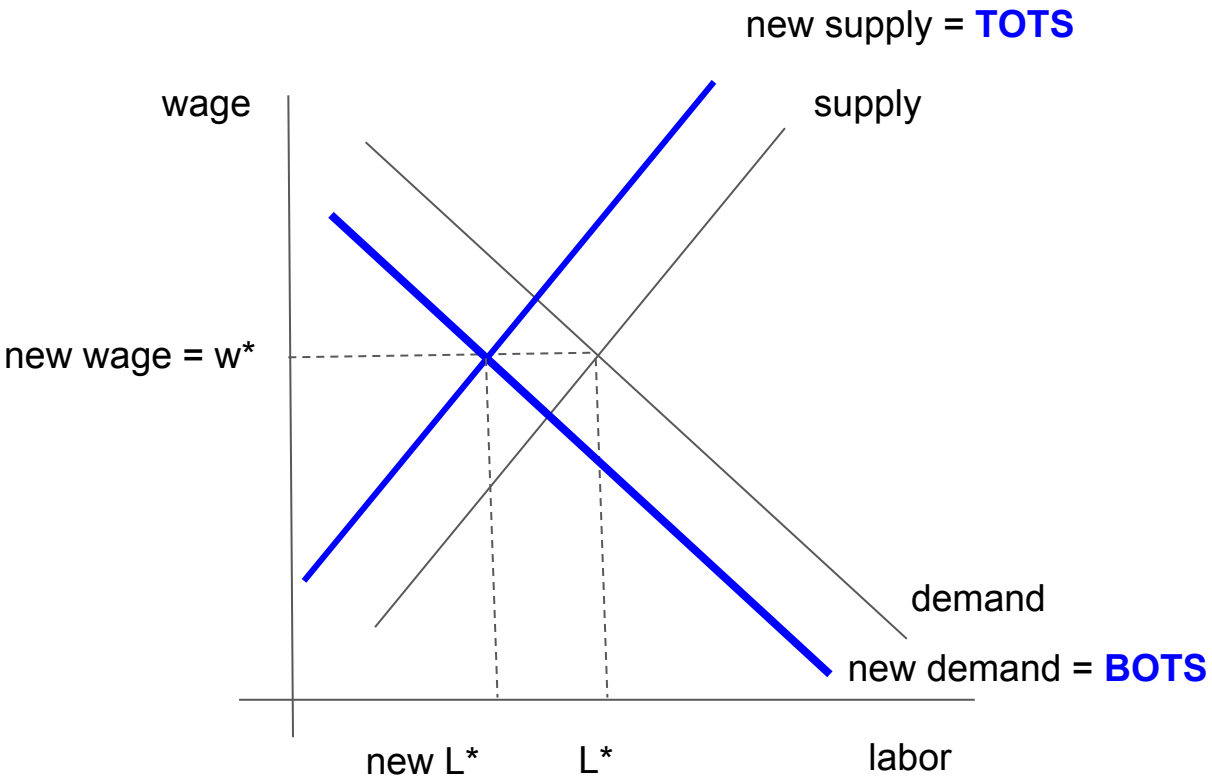
Economics of the labor market



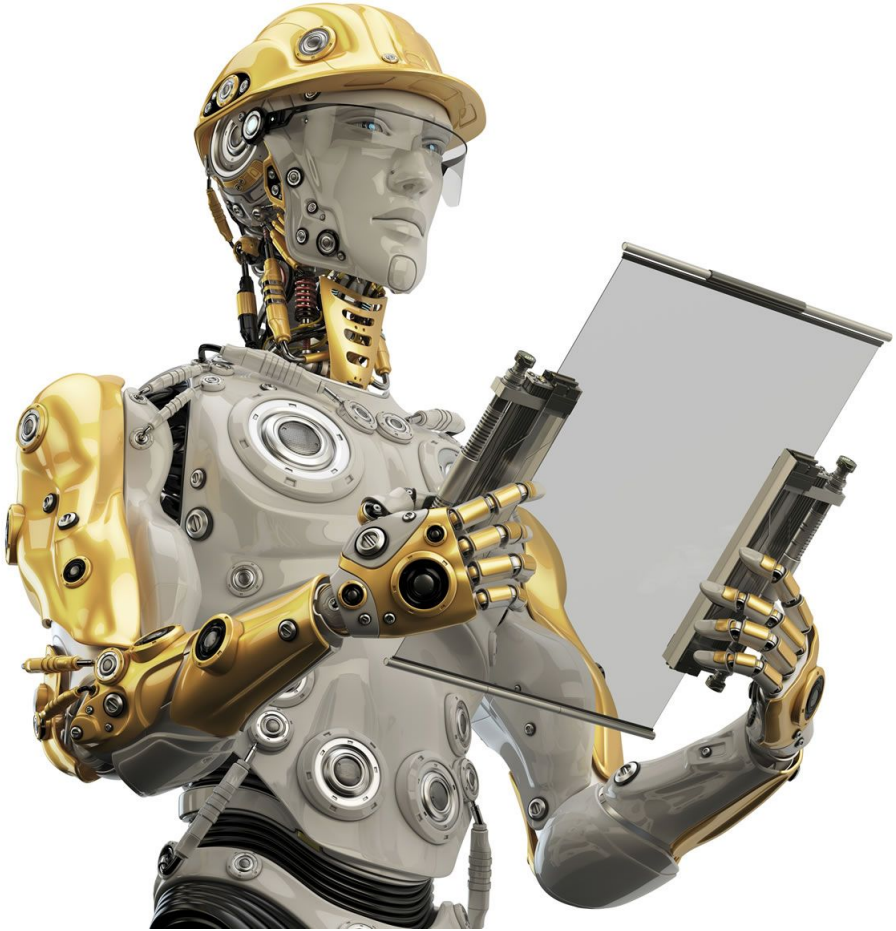
Economics of the labor market



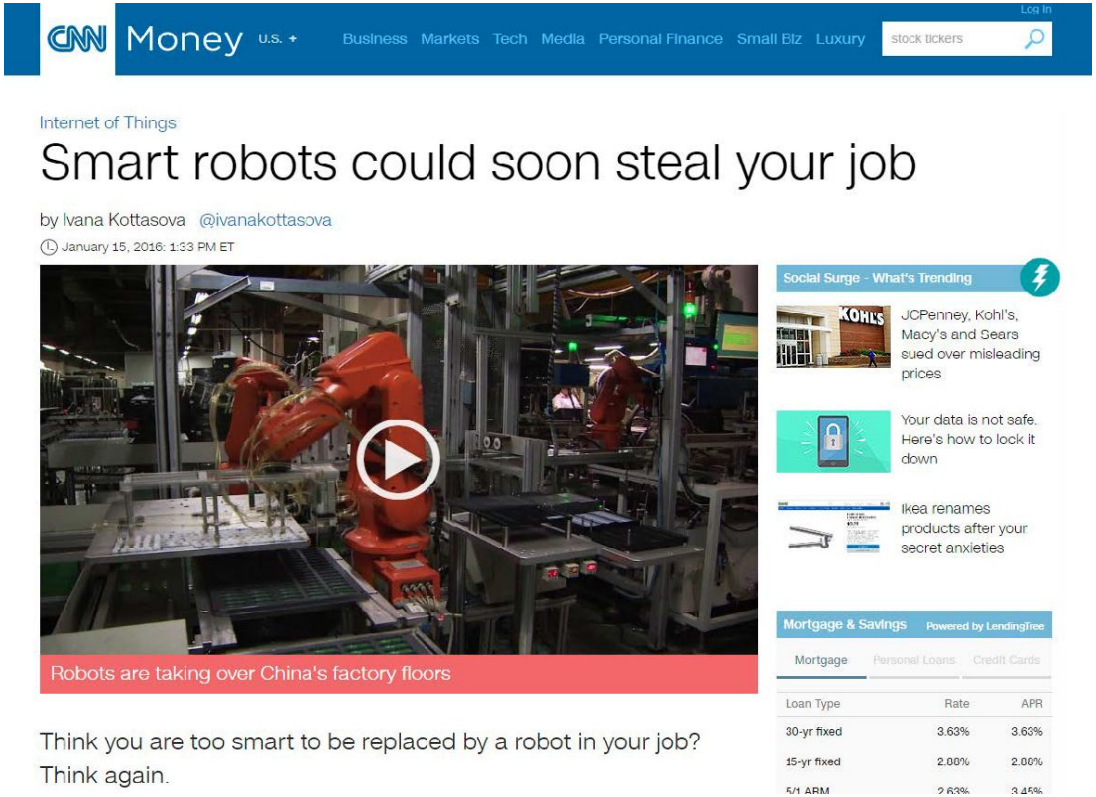
Economics of the labor market



Bots



2016: job stealing



CNN Money U.S. + Business Markets Tech Media Personal Finance Small Biz Luxury stock tickers Log In

Internet of Things

Smart robots could soon steal your job

by Ivana Kottasova @ivanakottasova

January 15, 2016: 1:33 PM ET

Robots are taking over China's factory floors

Think you are too smart to be replaced by a robot in your job? Think again.

Social Surge - What's Trending

JCPenney, Kohl's, Macy's and Sears sued over misleading prices

Your data is not safe. Here's how to lock it down

Ikea renames products after your secret anxieties

Mortgage & Savings Powered by LendingTree

Mortgage Personal Loans Credit Cards

Loan Type	Rate	APR
30-yr fixed	3.63%	3.63%
15-yr fixed	2.88%	2.88%
5/1 ARM	2.63%	3.45%

Jason Furman

1980: job stealing



A Robot Is After Your Job

By Harley Shaiken

DETROIT — Technological innovation is widely billed as a miracle cure for the United States' economic doldrums. Its aftereffects, however, may be far from benign. The introduction of revolutionary new technologies such as robots — versatile computer-controlled mechanical arms — raise two painful possibilities: sizeable losses of jobs and a deteriorated quality of working life.

The threat of lost jobs, although also dependent on social and economic factors, is especially critical. Auto makers are already buying robots in record numbers, despite a downturn that has resulted in 250,000 indefinite layoffs. Even the faltering Chrysler Corporation has added 128 of these new "recruits" to its work force for the 1981-model year.

But the robot is only one part of a larger computerization that is affecting virtually every productive activity in society from the office to the machine shop. In fact, many white-collar occupations that promised jobs to displaced blue-collar workers in the past are themselves being automated.

In the case of robots, relatively conservative estimates predict that sales in this country will grow at a compound rate of 25 percent a year for the next decade, culminating in annual sales of $800 million and production of 17,000 robots a year by 1990. While this hardly seems threatening to a manufacturing work force of 20 million people, robots are only one of the labor-displacing technologies being introduced. Moreoever, the employment effects are culmulative and have a disproportionate impact on a few key industries. Robots that begin work tomorrow will still be on the job in 1990, giving us a robot population of about 80,000. If 40 percent wind up in the auto industry (compared to 55 percent worldwide today), 32,000 robots could displace more than 100,000 auto workers. In fact, the potential loss of jobs is more serious than these figure indicate. New breakthroughs in robot technology such as "sight" and "feel" mean that each robot could displace far more workers in a decade. In addition, some industry observers feel that companies that sell computers may enter the market, resulting in a robot-population explosion in the hundreds of thousands, not tens of thousands.

The quality of working life will also change. While the first generation of robots primarily did such hazardous and hot jobs as welding and foundry work, robots are now being created for jobs where workers have the most control over the pace of work: machine loading and light assembly, among the more desirable production tasks.

[illegible] pervasive to assume that enough jobs will automatically be created for the number of people displaced. Economic revitalization no longer means re-employment. And the devastating social cost of unemployment is not reckoned in the savings that technology promises.

Such a socially destructive use of technology need not be inevitable. Jobs for workers displaced and improved working conditions for those who remain ought to be a condition for the introduction of robots. Productivity gains, for example, could translate into a shorter work week at the same pay rather than into fewer jobs. Technology could be designed to enhance human skill and experience rather than make people "interchangeable" with machines. Realistically, these alternatives require worker-union participation in the design and deployment of technology.

The goal, after all, should be a technology that benefits people — not one that destroys them.

Harley Shaiken, a research fellow at the Massachusetts Institute of Technology, is completing a book on automation.

Jason Furman

1960: job stealing

Robots' Rise

They Bid for Big Jobs Both in Outer Space And in U.S. Factories

A.M.F. Designs Robot to Send To Moon; G.E. Works on One to Paint New Autos

Beetle's Hazardous Mission

BY THOMAS O'TOOLE
Staff Reporter of THE WALL STREET JOURNAL

GREENWICH, Conn.—America's first astronaut to reach another planet may have long spidery arms and a bell-shaped head with a window in it.

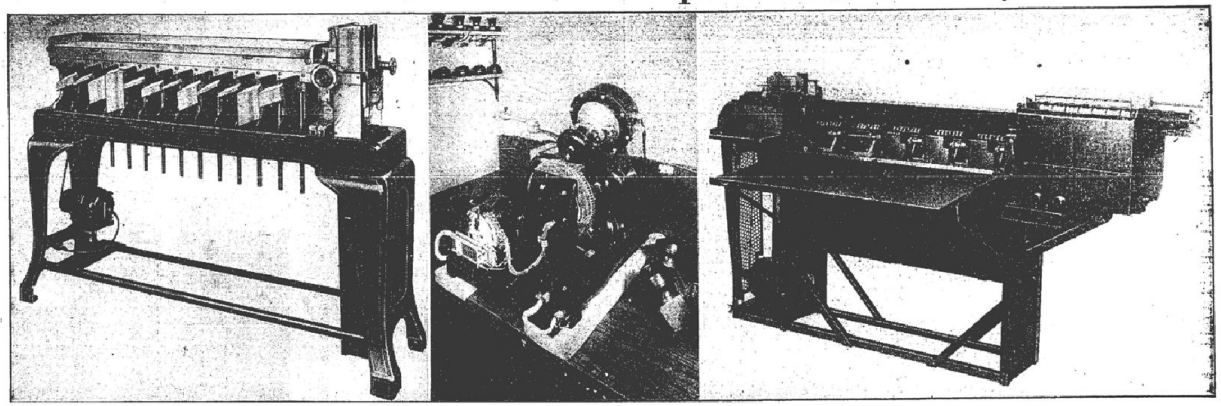
Such an inhuman-appearing space traveler is not as far-fetched as it seems. Even now the creature—a robot—is taking shape here at the Greenwich Engineering division laboratories of American Machine & Foundry Co. A.M.F. engineers believe their robot, remotely controlled from earth, would be far more useful than a human in exploring outer space—at least until rockets can be made powerful enough to be readily capable of returning home from trips to the Moon, Mars, Venus of even more distant targets.

Elsewhere around the country in laboratories and on drawing boards, increasing attention is being paid to robots, once regarded as science-fiction characters with little or no practical value. Indeed, most of the robots in use and development today bear little resemblance to the mechanical bipeds popularized by movie makers and cartoonists. But these machines, nevertheless, are true robots—automatic devices that perform human functions, or operate with seemingly human intelligence.

Jason Furman

1935: job stealing

Robot Brains Outdo Man's Mind in Speed and Accuracy of Results

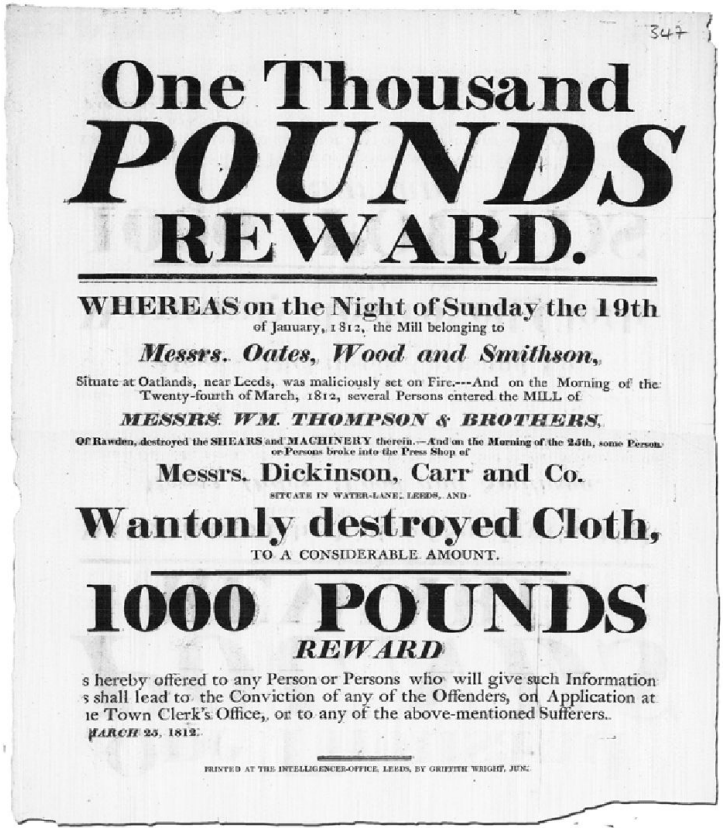


'Thinking Machines' Replace the Thinker

They Predict Tides, Pick Criminals' Fingerprints, Calculate Mathematical Problems, and Perform Amazing Tasks.

Jason Furman

1812: job stealing



347

One Thousand
POUNDS
REWARD.

WHEREAS on the Night of Sunday the 19th of January, 1812, the Mill belonging to

Messrs. Oates, Wood and Smithson,

Situate at Oatlands, near Leeds, was maliciously set on Fire.---And on the Morning of the Twenty-fourth of March, 1812, several Persons entered the MILL of

MESSRS. WM. THOMPSON & BROTHERS,

Of Rawden, destroyed the SHEARS and MACHINERY therein.—And on the Morning of the 25th, some Person or Persons broke into the Press Shop of

Messrs. Dickinson, Carr and Co.

SITUATE IN WATER-LANE, LEEDS, AND

Wantonly destroyed Cloth,

TO A CONSIDERABLE AMOUNT.

1000 POUNDS
REWARD

s hereby offered to any Person or Persons who will give such Information s shall lead to the Conviction of any of the Offenders, on Application at ıe Town Clerk's Office,, or to any of the above-mentioned Sufferers.

MARCH 25, 1812.

PRINTED AT THE INTELLIGENCER-OFFICE, LEEDS, BY GRIFFITH WRIGHT, JUN.

Jason Furman

2017: Huh?

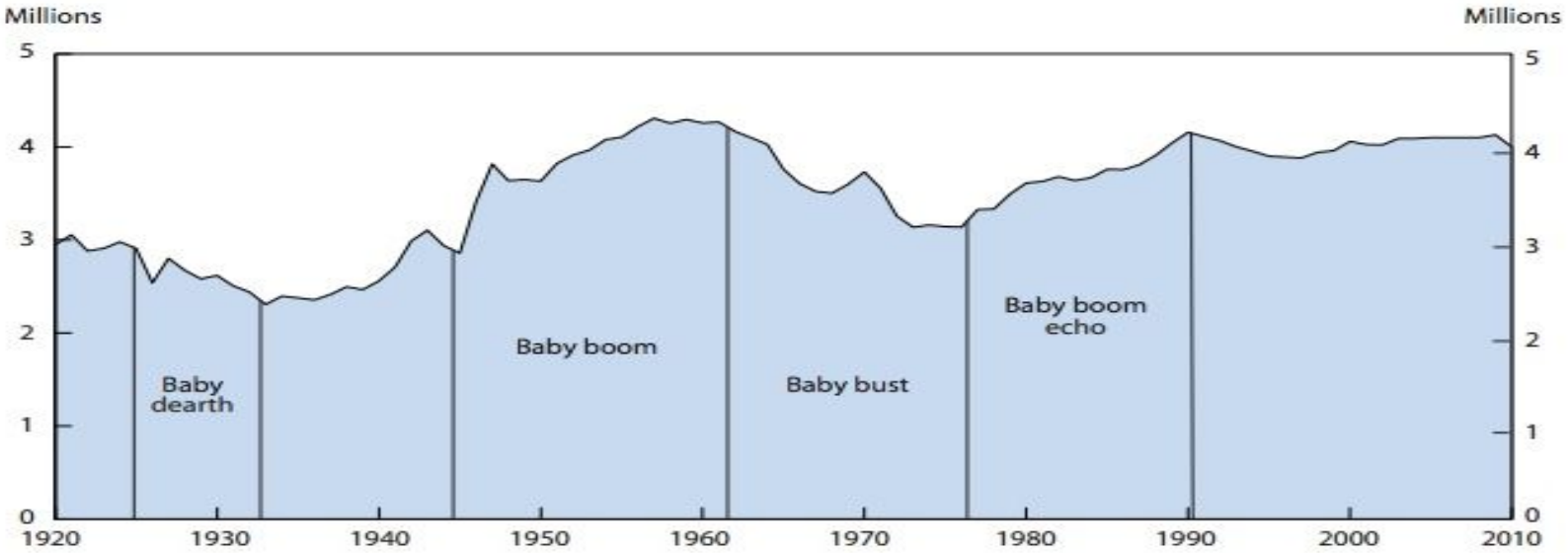


Construction, agriculture, truck drivers, forklift drivers, dairy farms, meat packing ...

The economy can absorb large shocks to labor market

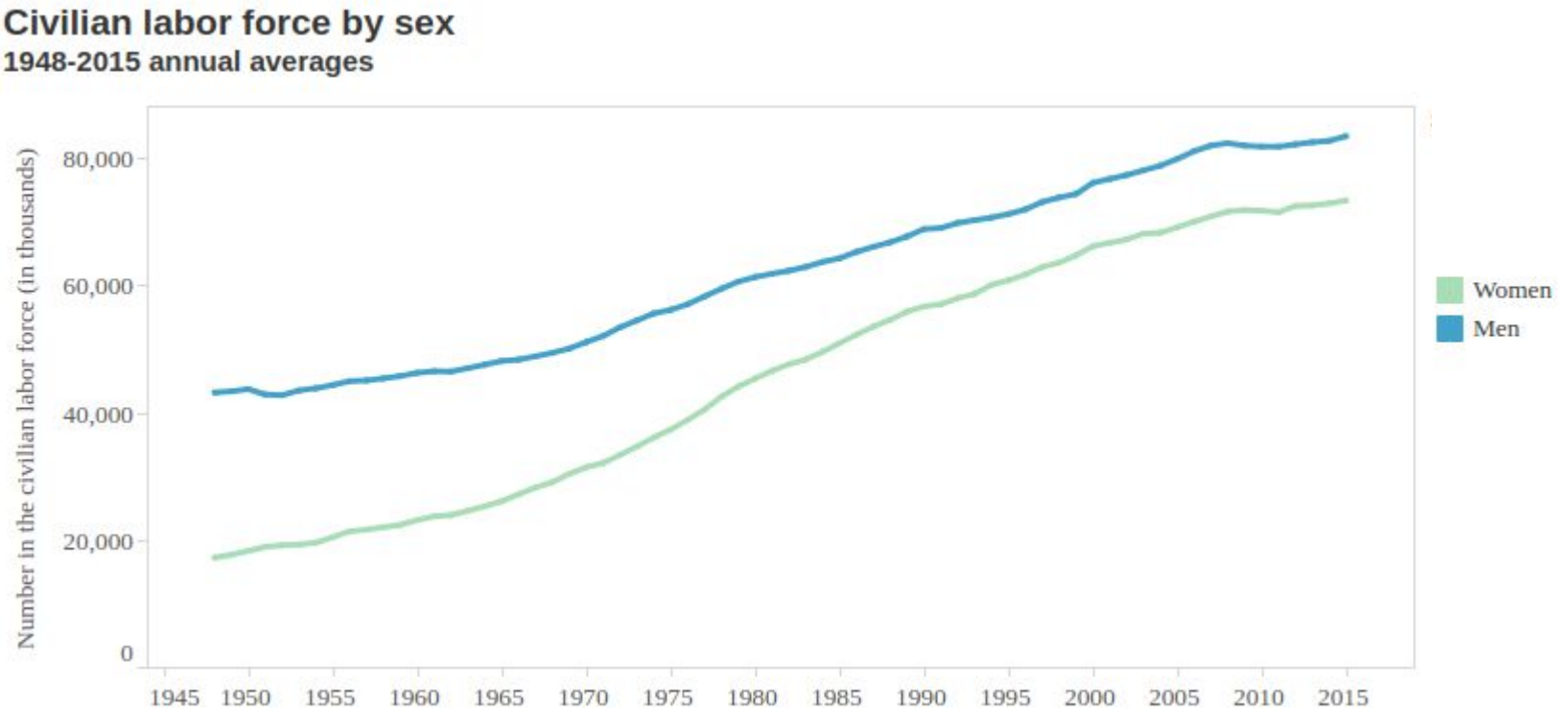
Baby boomers

1. Live births by year, 1920–2010



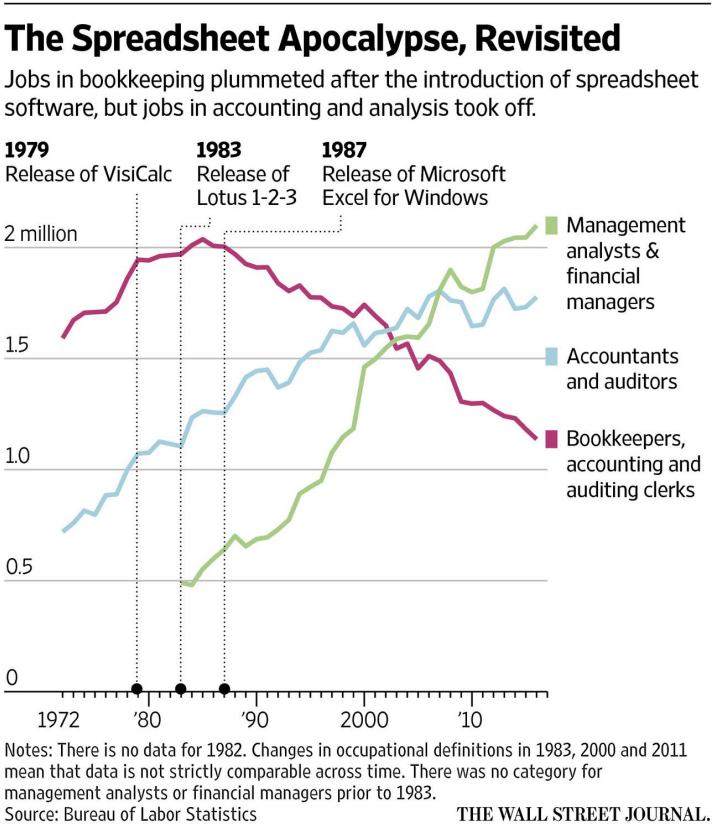
Bureau of Labor Statistics

Women entering the (paid) labor force



Dept of Labor

Spreadsheet apocalypse

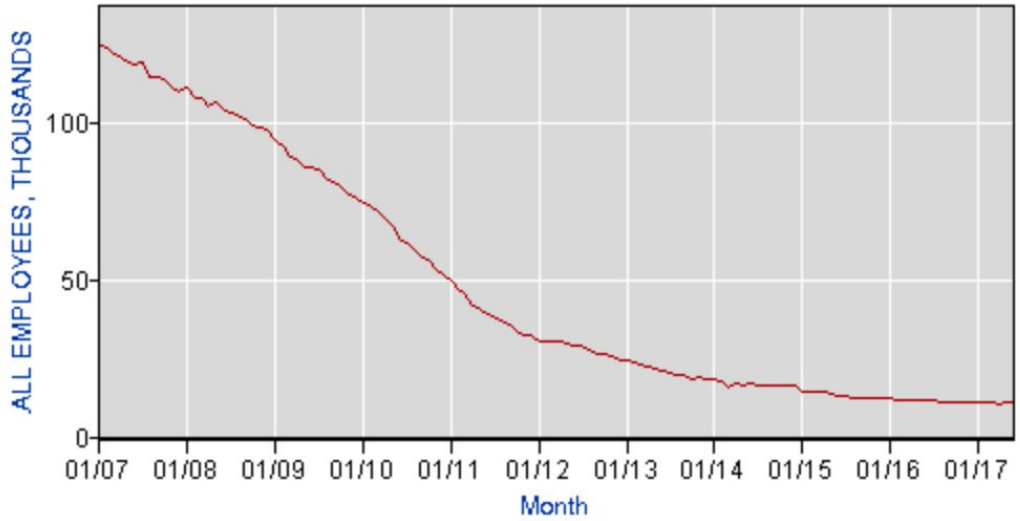


Wall Street Journal

Video rental clerks

Employment, Hours, and Earnings from the Current Employment Statistics survey (National)

Series Id: CES5553223001 (I)
Seasonally Adjusted
Series Title: All employees, thousands, video tape and disc rental, seasonally adjusted
Super Sector: Financial activities
Industry: Video tape and disc rental
NAICS Code: 53223
Data Type: ALL EMPLOYEES, THOUSANDS



Jobs and tasks

Automation, jobs and tasks

Automation doesn't generally eliminate jobs. Automation generally eliminates dull, tedious, and repetitive **tasks**.

- **Manual:** washing clothes, drying dishes, mowing lawn, digging holes, chopping wood
- **Cognitive:** making change for purchase, memorizing maps, adding columns of numbers

If you eliminate *all* the tasks associated with a job, you have eliminated a job. But this is rare.

Tasks and jobs

There were 270 detailed occupations listed in the 1950 US Census. Only 1 has been eliminated due to automation.

Quartz article based on Jim Bessen's work

Tasks or jobs?

There were 270 detailed occupations listed in the 1950 US Census. Only 1 has been eliminated due to automation.

Elevator operator



Quartz article based on Jim Bessen's work

Even elevator operators had other tasks...

- Operation
  - Safety monitor
  - Security monitor
  - Greeter
  - Provide answers to questions
  - Provide services to residents
  - Announced special prices or offers
- Many such tasks were folded into other jobs (reception, security)
- Most jobs are more complicated than we think...

Interview Wikipedia

Groundskeeper tasks: O*NET

- Gather and remove litter.
- Use hand tools, such as shovels, rakes, pruning saws, saws, hedge or brush trimmers, or axes.
- Operate vehicles or powered equipment, such as mowers, tractors, twin-axle vehicles, snow blowers, chain-saws, electric clippers, sod cutters, or pruning saws.
- Water lawns, trees, or plants, using portable sprinkler systems, hoses, or watering cans.
- Prune or trim trees, shrubs, or hedges, using shears, pruners, or chain saws.
- Mix and spray or spread fertilizers, herbicides, or insecticides onto grass, shrubs, or trees, using hand or automatic sprayers or spreaders.
- Care for established lawns by mulching, aerating, weeding, grubbing, removing thatch, or trimming or edging around flower beds, walks, or walls.
- Follow planned landscaping designs to determine where to lay sod, sow grass, or plant flowers or foliage.

MORE

Groundskeeper tasks, continued

- Trim or pick flowers and clean flower beds.
- Attach wires from planted trees to support stakes.
- Plant seeds, bulbs, foliage, flowering plants, grass, ground covers, trees, or shrubs and apply mulch for protection, using gardening tools.
- Mow or edge lawns, using power mowers or edgers.
- Rake, mulch, and compost leaves.
- Decorate gardens with stones or plants.
- Provide proper upkeep of sidewalks, driveways, parking lots, fountains, planters, burial sites, or other grounds features.
- Shovel snow from walks, driveways, or parking lots and spread salt in those areas.
- Maintain irrigation systems, including winterizing the systems and starting them up in spring.
- Plan or cultivate lawns or gardens.
- Install rock gardens, ponds, decks, drainage systems, irrigation systems, retaining walls, fences, planters, or playground equipment.

Robots and tasks

Could we build a robotic groundskeeper?

- You could likely automate any single task with enough money and time
- But automating them all would be very challenging

Robots work best with standardized environment and repetitive tasks.

- We have been optimizing the assembly line with humans for 100 years
- It’s not surprising that this environment is (relatively) easy to automate
- Half of all industrial robots are in auto plants

A heterogeneous environment is much more difficult, even when each task is relatively simple. Generally, we have seen machines that *augment* humans, not replaced them.

Ideal environment for robot gardener



Hotel housekeeper O*NET

- Carry linens, towels, toilet items, and cleaning supplies, using wheeled carts.
- Disinfect equipment and supplies, using germicides or steam-operated sterilizers.
- Clean rooms, hallways, lobbies, lounges, restrooms, corridors, elevators, stairways, locker rooms, and other work areas so that health standards are met.
- Empty wastebaskets, empty and clean ashtrays, and transport other trash and waste to disposal areas.
- Observe precautions required to protect hotel and guest property and report damage, theft, and found articles to supervisors.
- Replenish supplies, such as drinking glasses, linens, writing supplies, and bathroom items.
- Clean rugs, carpets, upholstered furniture, and draperies, using vacuum cleaners and shampooers.
- Dust and polish furniture and equipment.
- Keep storage areas and carts well-stocked, clean, and tidy.
- Wash windows, walls, ceilings, and woodwork, waxing and polishing as necessary.
- Move and arrange furniture and turn mattresses.
- Hang draperies and dust window blinds.

Ideal environment for housekeeper robot



Orchards


QUALITY
APPLES
GROWN & PACKED BY
VARIAN'S
WOOSTER ORCHARD
WOOSTER, OHIO
PHONE AN 3-4121

Traditional orchard v modern orchard





Make the environment as homogeneous as possible (like the assembly line).

Source: Goodfruit

Easier for humans and robots





Can we replace humans with humanoid robots?

First invasion of the machines (1880s)

- Washing machines, dryers, dishwashers, vacuum cleaners, sewing machines
- None of these work like humans
- Key to eliminating routine labor is to standardize environment and eliminate routine work
- Airplanes don’t fly by flapping their wings, cars don’t walk, boats don’t swim

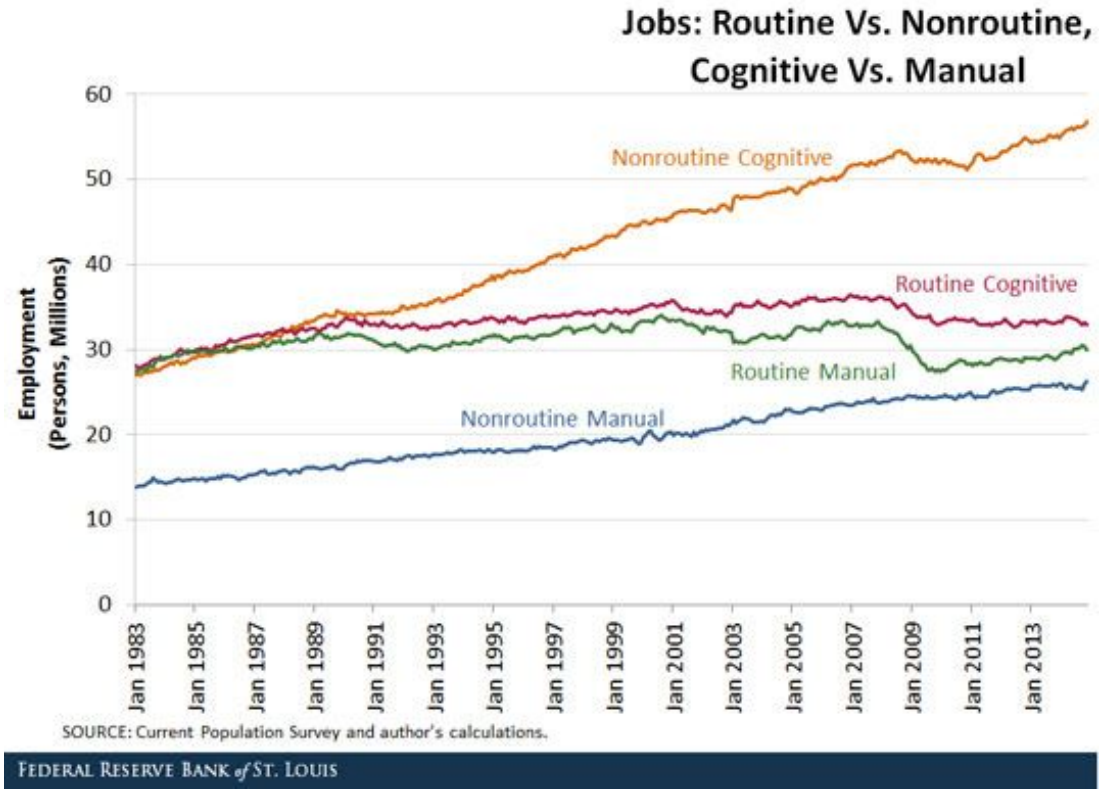
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- None of these work like humans
- Key to eliminating routine labor is to standardize environment and eliminate routine work
- Airplanes don’t fly by flapping their wings, cars don’t walk, boats don’t swim
- With a few exceptions...



Routine v Nonroutine work



[Jobs Involving Routine Tasks Aren't Growing]

From Henry Ford to Elon Musk

“In mass production there are no fitters.” Henry Ford 1929

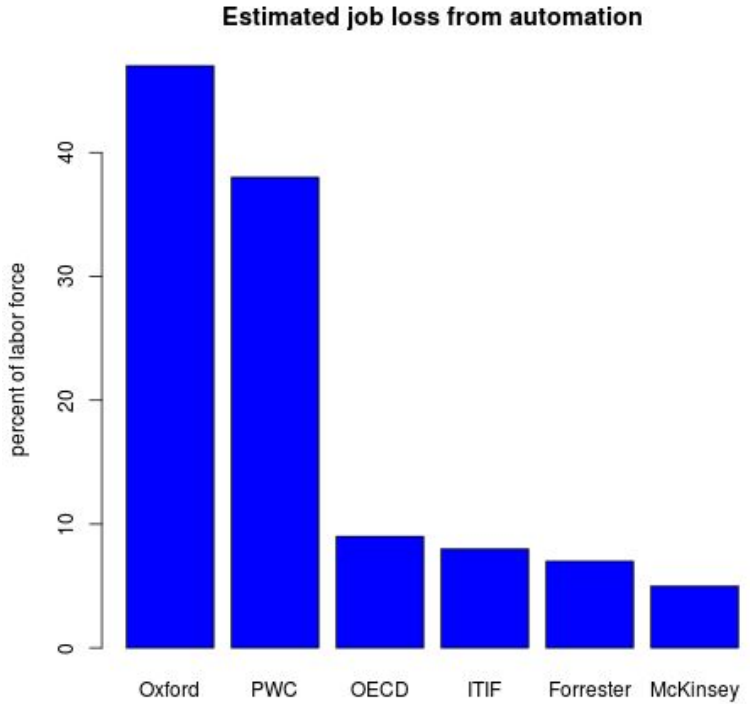
“Yes, excessive automation at Tesla was a mistake. To be precise, my mistake. **Humans are underrated.**” Elon Musk 2018

“In final assembly, robots can apply torque consistently—but they don’t detect and account for threads that aren’t straight, bolts that don’t quite fit, fasteners that don’t align or seals that have a defect. Humans are really good at this. Have you wondered why Teslas have wind-noise problems, squeaks and rattles, and bits of trim that fall off? Now you have your answer.” Bernstein 2018

Heterogeneity is still a problem….

Tasks and jobs

- What tasks can be automated?
- How will tasks associated with jobs change?
- What jobs can be automated?
- What fraction does it make economic sense to automate?
- Depends what and who you ask...



Other estimates

Predicted Jobs Automation Will Create and Destroy

When	Where	Jobs Destroyed	Jobs Created	Predictor
2016	worldwide		900,000 to 1,500,000	Metra Martech
2018	US jobs	13,852,530	3,078,340	Forrester
2020	worldwide		1,000,000-2,000,000	Metra Martech
2020	worldwide	1,800,000	2,300,000	Gartner
2020	sampling of 15 countries	7,100,000	2,000,000	World Economic Forum (WEF)
2021	worldwide		1,900,000-3,500,000	The International Federation of Robotics
2021	US jobs	9,108,900		Forrester
2022	worldwide	1,000,000,000		Thomas Frey
2025	US jobs	24,186,240	13,604,760	Forrester

Predicted Jobs Automation Will Create and Destroy

When	Where	Jobs Destroyed	Jobs Created	Predictor
2025	US jobs	3,400,000		ScienceAlert
2027	US jobs	24,700,000	14,900,000	Forrester
2030	worldwide	2,000,000,000		Thomas Frey
2030	worldwide	400,000,000-800,000,000		McKinsey
2030	US jobs	58,164,320		PWC
2033	US jobs	67,876,460		Oxford University
2035	US jobs	80,000,000		Bank of England
2035	UK jobs	15,000,000		Bank of England
No Date	US jobs	13,594,320		OECD
No Date	UK jobs	13,700,000		IPPR

Technology Review

Ten largest occupations in US

Retail salesperson, cashier, food preparation, office clerk, registered nurse, customer service representative, waiter/waitress, laborer, administrative assistant, and janitor.

1. These 10 jobs account for 21% of total employment.
2. All are in services (which is 80% of private US employment.)
3. Mean income: $47,230. Registered nurse: $69,790; food preparation workers make an average of $19,110
4. Most of these *jobs* are too difficult for robots, but many of the *tasks* could be automated to a degree.

Quartz

Work week across time and space

What happens if we do become ultra productive?

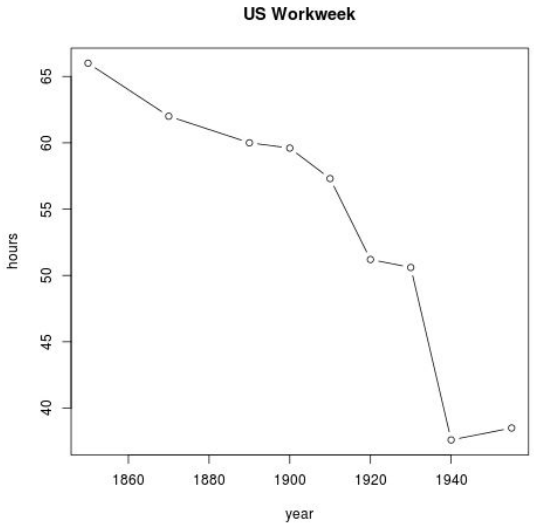
If automation increases productivity by 25%, we can accomplish in 4 days what now takes 5. How does work change?

- Work less each (day, week, lifetime)
- Consume more each (day, week, lifetime)

Workweek

Time

Year	Hours
1850	66
1870	62
1890	60.0
1900	59.6
1910	57.3
1920	51.2
1930	50.6
1940	37.6
1955	38.5



Space

Country	Hours
Belgium	35.2
Denmark	32.1
France	36.1
Germany	34.5
Italy	35.5
Mexico	45.2
Netherlands	29.1
Spain	36.5
Sweden	35.9
United Kingdom	36.5
United States	38.6

Economic History Assoc and OECD

What do people want?

What do people want?

“More jobs and less work”

What do people want?

“More jobs and less work”

And that’s exactly what technology can deliver.

What do people want?

“More jobs and less work”

And that’s exactly what technology can deliver.

Everybody loves a 3 day weekend!

What do people want?

“More jobs and less work”

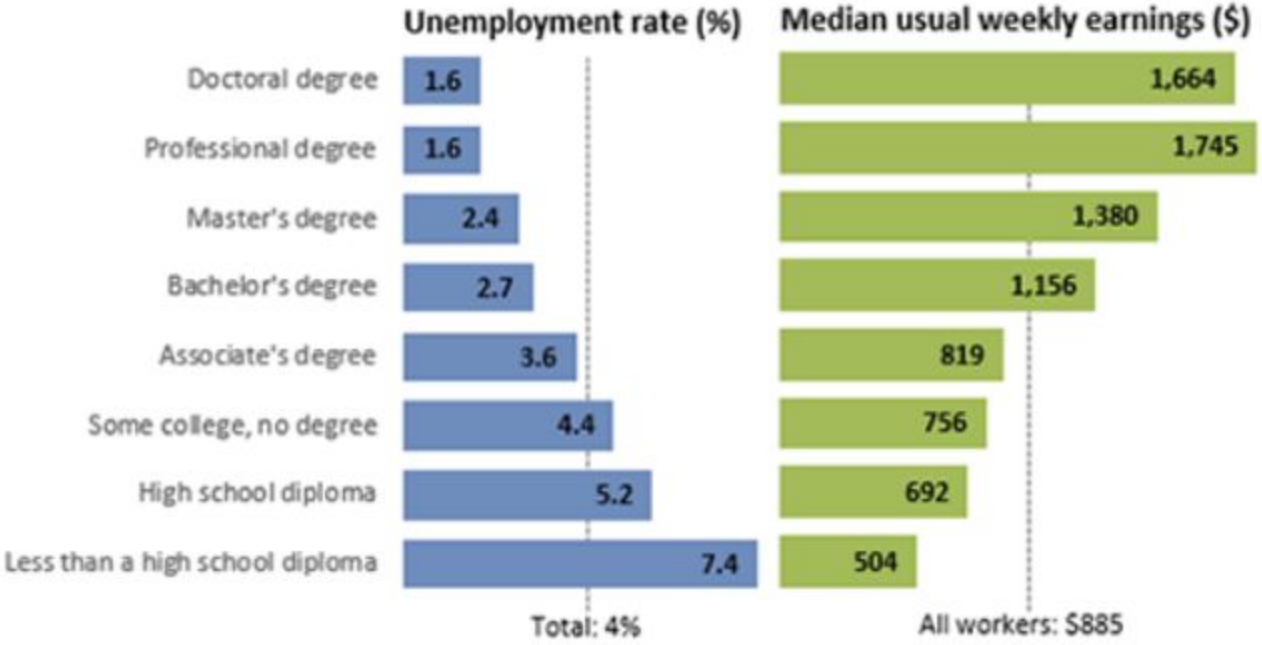
And that’s exactly what technology can deliver.

Everybody loves a 3 day weekend!

So why not make it permanent...

Education and training

Unemployment rates and earnings by educational attainment, 2016



Note: Data are for persons age 25 and over. Earnings are for full-time wage and salary workers.

Source: U.S. Bureau of Labor Statistics, Current Population Survey.

Bureau of Labor Statistics

Fallacy of composition for education

It's good for any individual to be more educated, but it is good for *everyone* to become more educated? Who will do the jobs that don't require much education? There will still be jobs for groundskeepers and hotel maids. However, some tasks will be automated and training will be necessary.

- Routine work: machines
- Exception handling: humans.

The best way to acquire training is on the job.

- Lower opportunity cost
- More relevant
- More focused
- Higher motivation

Delivery of instruction and training

Can technology help deliver on-the-job job skills?

Not only can technology deliver this, it already does!

There are 1 billion views a day of “how to videos” on YouTube

This is unprecedented in human history.

How to videos on YouTube: cognitive

Math by subject

- Early math
- Arithmetic
- Pre-algebra
- Algebra
- Geometry
- Trigonometry
- Precalculus
- Statistics & probability
- Calculus
- Differential equations
- Linear algebra
- Math for fun and glory

CS by subject

- Intro to algorithms
- Binary search
- Asymptotic notation
- Selection sort
- Insertion sort
- Recursive algorithms
- Towers of Hanoi
- Merge sort
- Quick sort
- Graph representation
- Breadth-first search
- Further learning

Khan Academy

How to videos on You Tube: manual

- **how to** sweat copper pipe
- **how to** install a prehung door
- **how to care** for mums
- **how to** do planks
- **how to** weld cast iron
- **how to** remove a stripped bolt
- **how to** shorten blinds
- **how to** clean glass pipe
- **how to** program a garage door opener
- **how to** get a stripped screw out
- **how to** remove a stripped screw
- **how to** clean a pipe
- **how to** shingle a roof
- **how to** tig weld
- **how to** solder copper pipe
- **how to** weld aluminum
- **how to** mig weld
- **how to** balance a ceiling fan
- **how to** install a storm door

Cognitive assistance

It used to be that being a...

- ...cashier required knowing how to make change
- ...writer required knowing how to spell
- ...taxi driver meant knowing city streets
- ...a hospitality worker in an international you know a bit of foreign languages
- ...gardener, you needed to recognize plants
- ...veterinarian how to recognize dog breeds

Where there is a skills gap, you can bring the worker's skills up to the requirement, or bring the job down to workers' competencies. Cognitive assistances helps people get jobs, by reducing the tasks they need to master.

- In 1880 machines offered *manual* assistance
- In 2018 machines offer *cognitive* assistance.

Summary of bots

- Demand for labor and supply of labor are both important
- Automation commonly replaces tasks, rarely replaces jobs
- Historically this has led to more jobs and less work
- Most jobs are more complex than intellectuals recognize
- Job training is ideally provided on the job
- Technology can help deliver training as needed
- Cognitive assistance helps match skills to jobs by 1) educating workers 2) educating machines
    - Training spinners or build a spinning jenny
    - Training taxi drivers or GPS system

Tots: demography



Productivity

output/person = output/hour x hours/worker x workers/person

= productivity x employment x participation

Productivity

output/person = output/hour x hours/worker x workers/person

= productivity x employment x participation

full

Productivity

output/person = output/hour x hours/worker x workers/person

= productivity x employment x participation

full **declining**

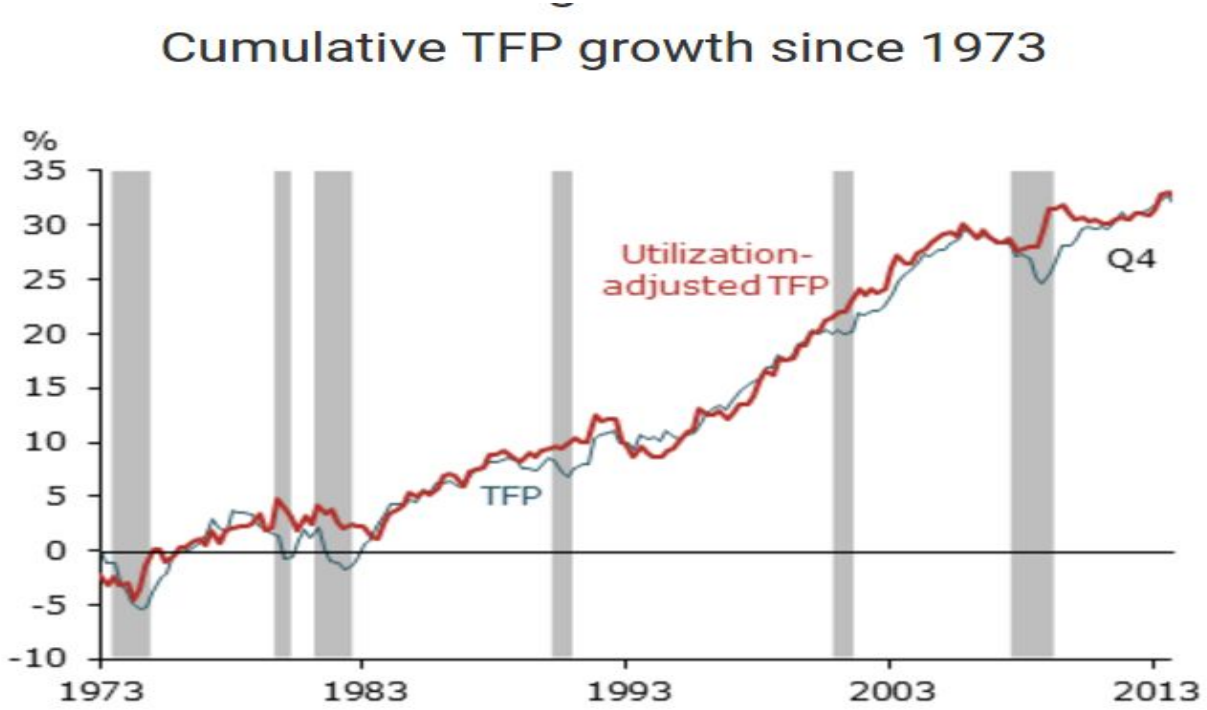
Productivity

output/person = output/hour x hours/worker x workers/person

= productivity x employment x participation

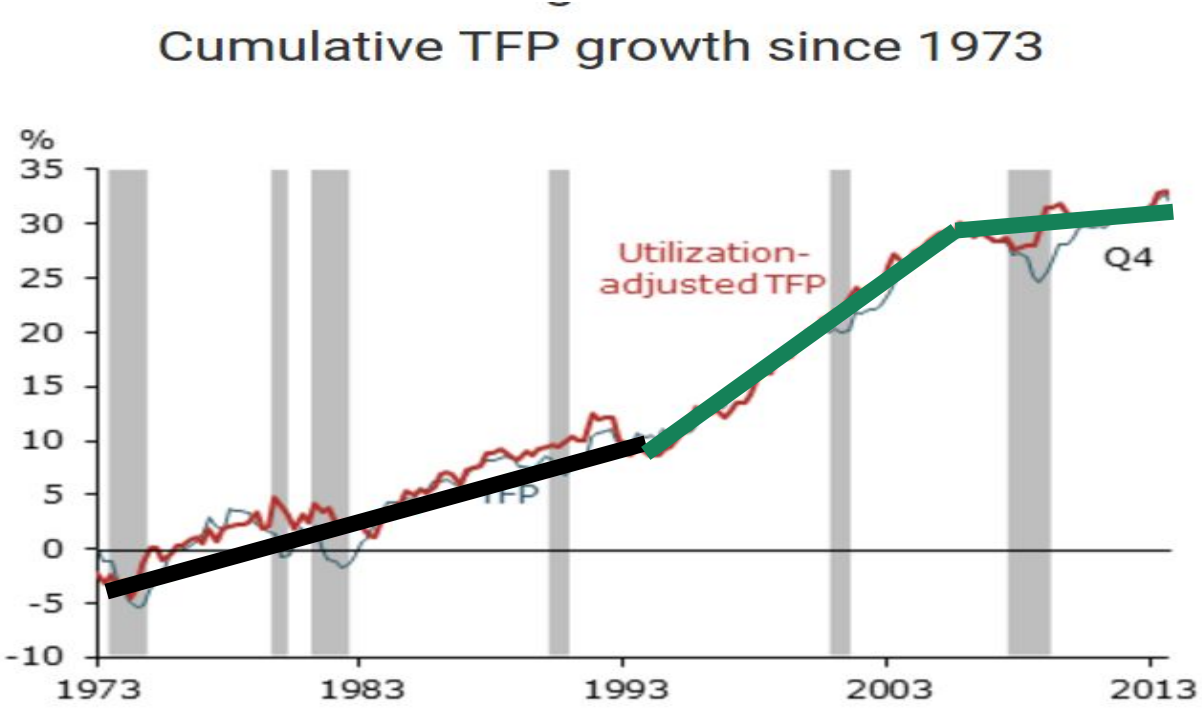
anemic **full** **declining**

Growth in productivity



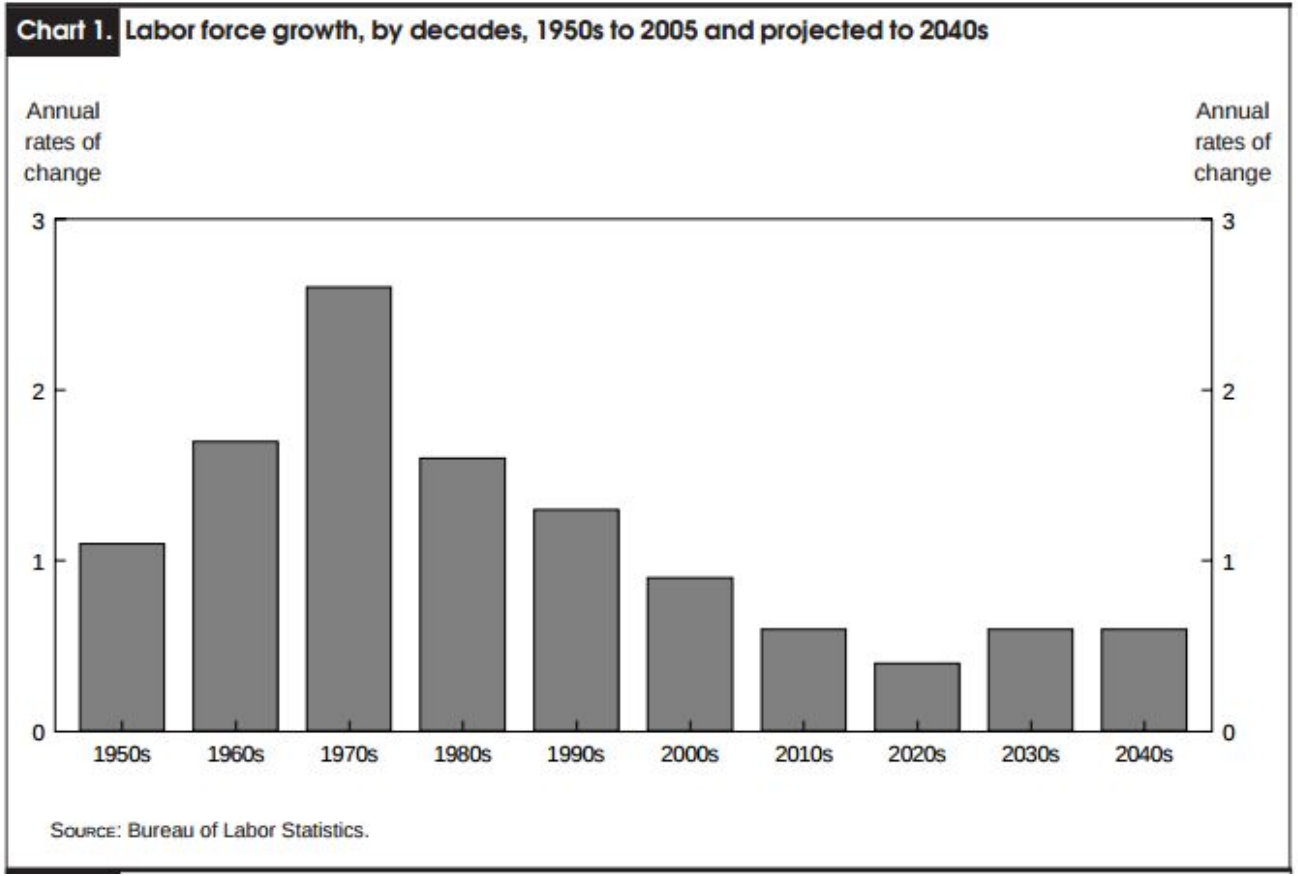
Source: Fernald and Wang, "The Recent Rise and Fall of Rapid Productivity Growth", SF Fed, Feb 2015

Growth in productivity



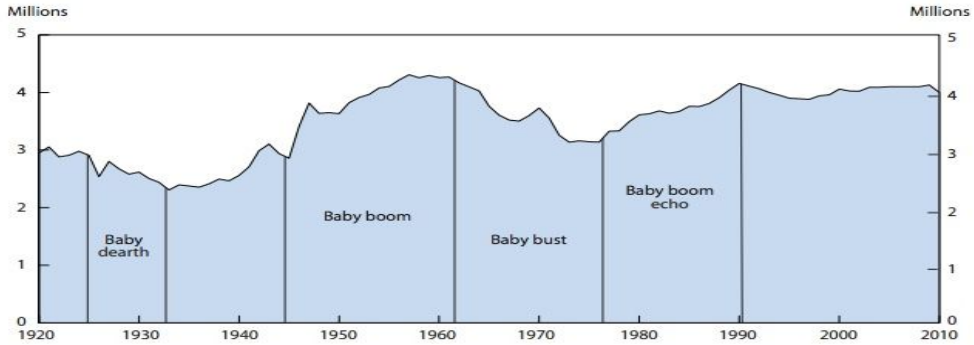
Source: Fernald and Wang, "The Recent Rise and Fall of Rapid Productivity Growth", SF Fed, Feb 2015

Growth of the labor force

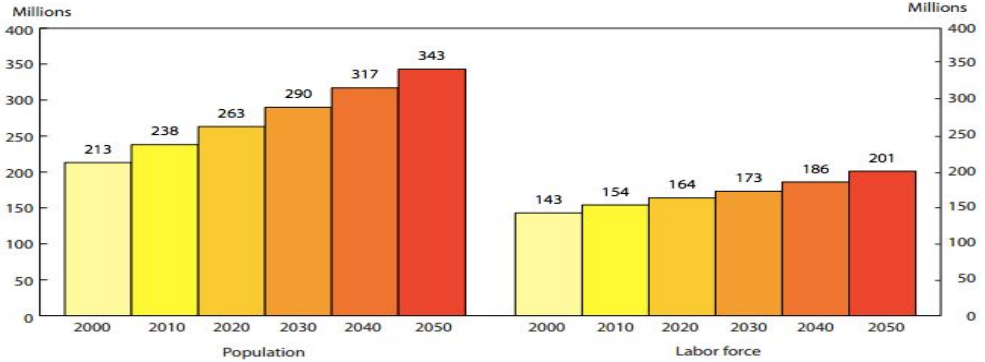


Demography is destiny

1. Live births by year, 1920–2010



2. Population and labor force, 2000, 2010, and projected 2020, 2030, 2040, and 2050

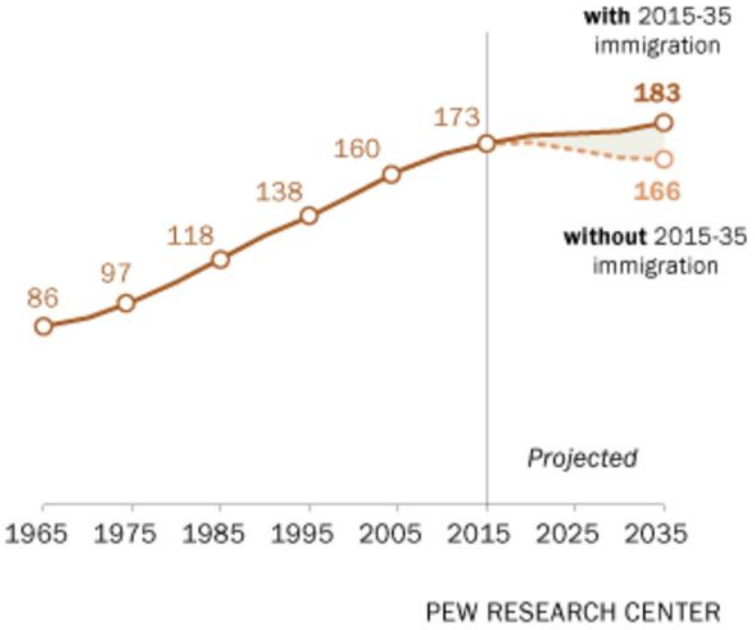


[Bureau of Labor Statistics]

Immigration

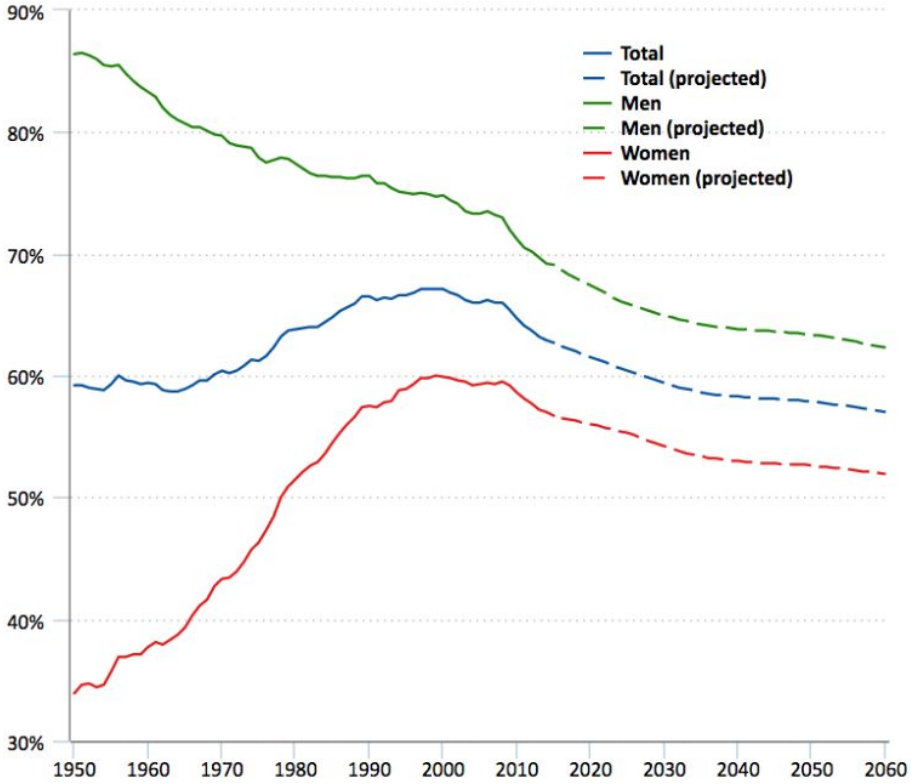
Without future immigrants, working-age population in U.S. would decrease by 2035

Working-age population (25-64), in millions



Source: Pew Research Center estimates for 1965-2015 based on adjusted census data; Pew Research Center projections for 2015-35.

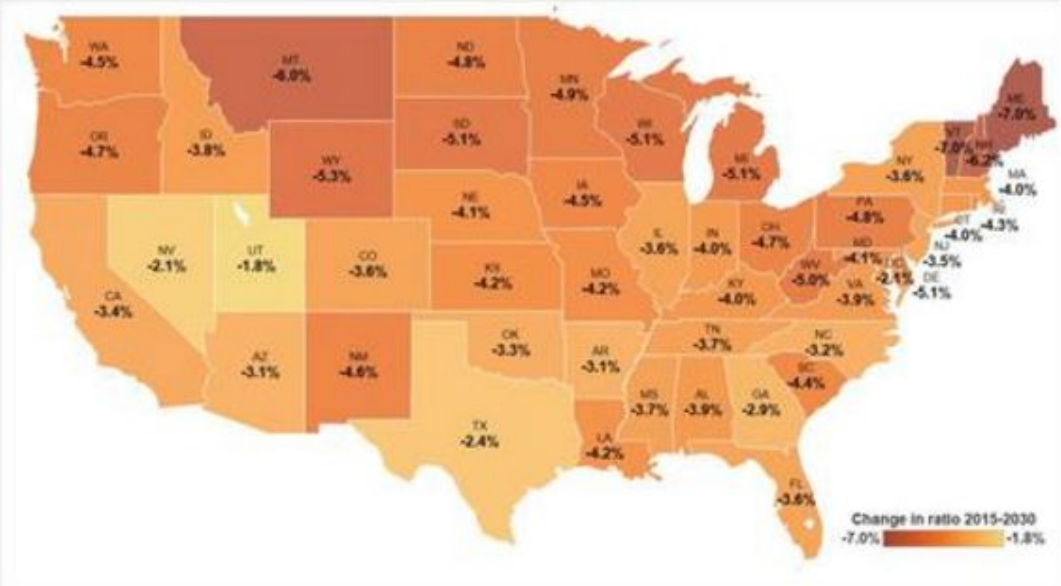
Labor force participation rates



Bureau of Labor Statistics

Where will labor shortage be worst?

Chart 1: Change in ratio of people aged 20 to 64 over total population, 2015 to 2030 *(Click to expand)*.



The Conference Board

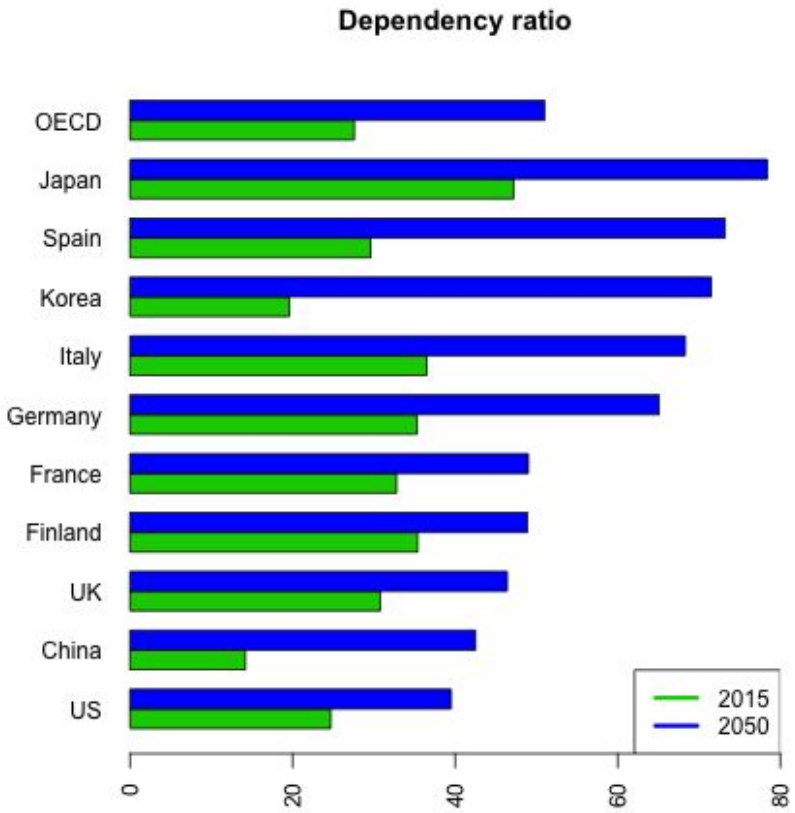
Growth in population and labor force

Decade	Population growth	Labor Force growth
2010	18.4%	7.7%
2020	10.5%	6.5%
2030	10.3%	5.5%
2040	9.3%	7.5%
2050	8.2%	8.1%

- US labor market is already beginning to tighten
- Expect a tight labor market for the next 15-25 years
- Retirees continue to consume
- Labor supply is growing more slowly than labor demand.
- Old intuitions no longer helpful
- Countervailing forces
  - 2000: 3% of 65+ working
  - 2016: 12.4% of 65+ working

Gad Levanon, Conference Board

US is in good shape compared to many countries



People over 65 for every 100 people of working age. Source: OECD

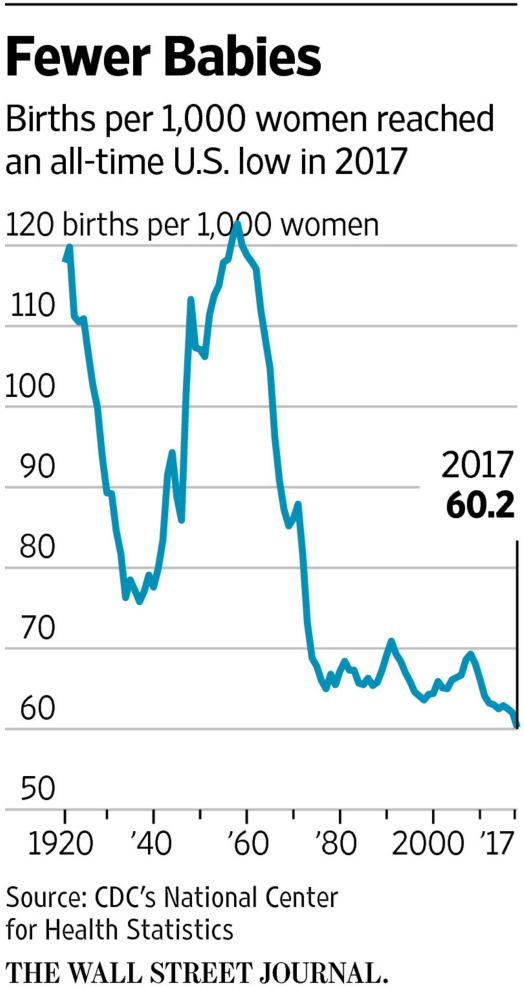
OECD

And the US birth rate is at an all-time low!

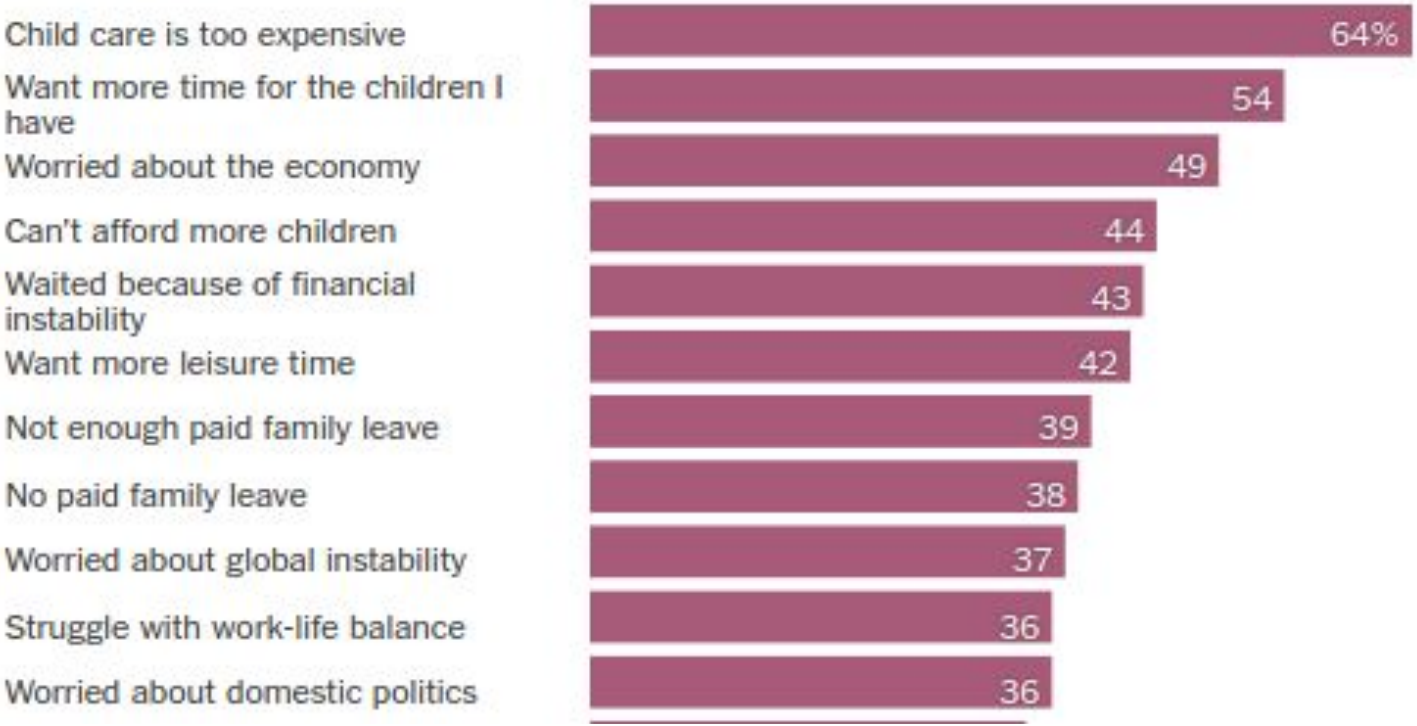
"This dearth of births could exacerbate the problems of America's aging population. Many baby boomers are in or are near retirement, leaving a smaller share of young workers to pay into Social Security and Medicare.

That is creating a funding imbalance that strains the social safety net that supports the elderly."

Source: WSJ, May 17, 2018

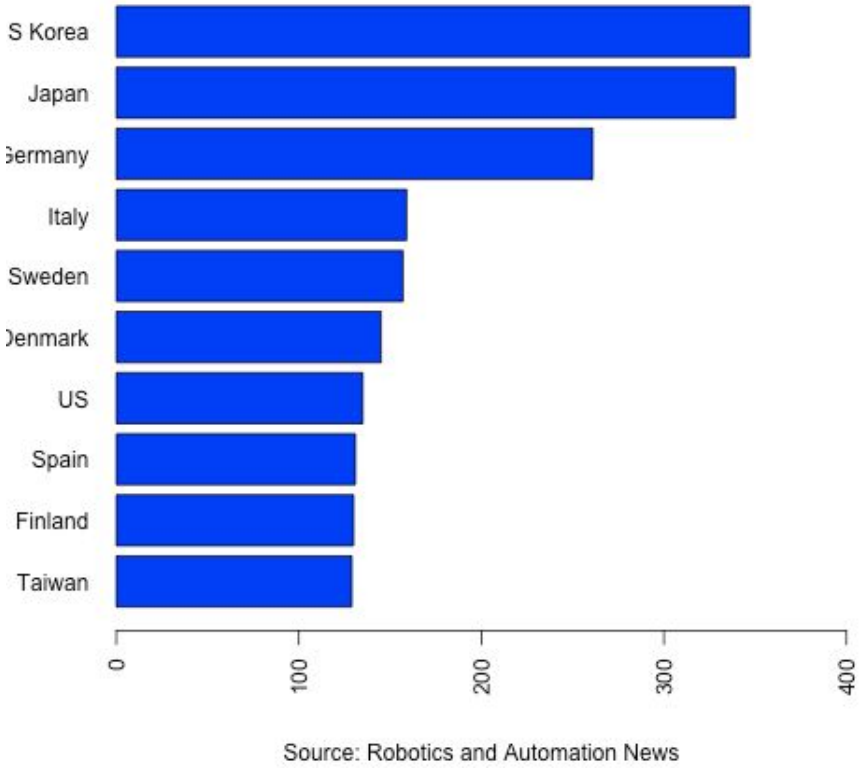


Why is US birth rate low?



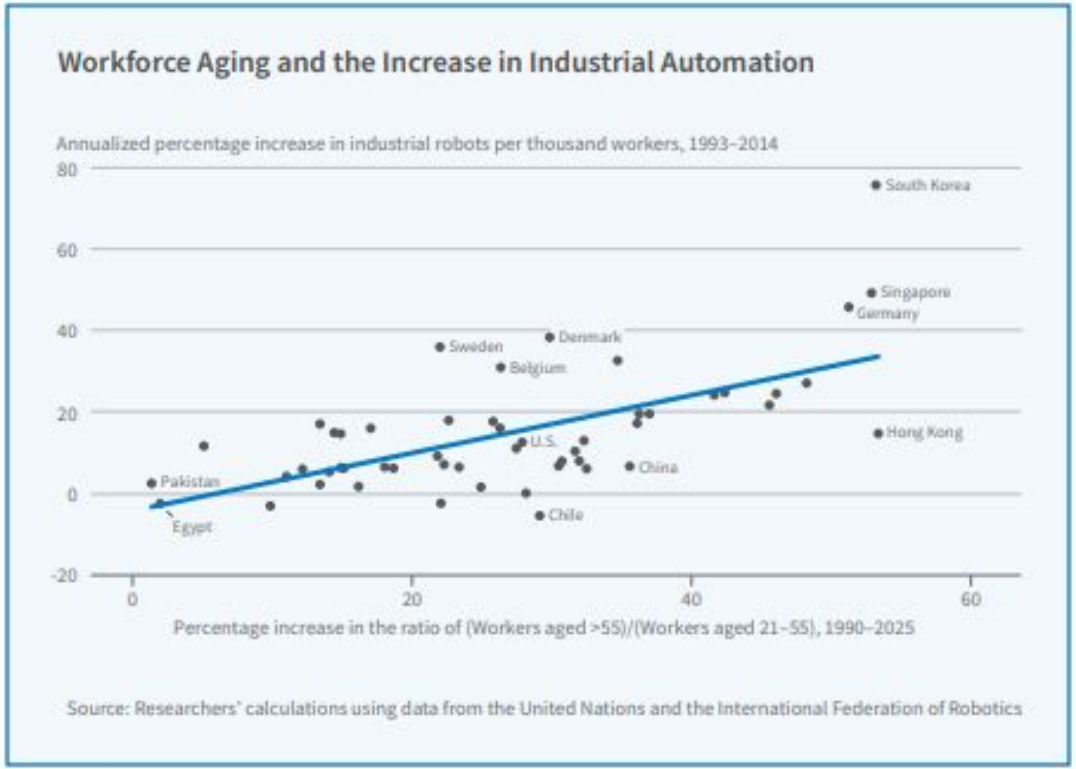
Source: New York Times, July 5, 2018

Robots per 10,000 workers



Countries with bad demographics are investing in robots. See Acemoglu and Restrepo [2017, 2018] for detailed analysis.

Workforce aging and increased industrial automation



Source: Acemoglu and Restrepo (2018)

Bots v Tots: which is bigger effect?

- Boston Consulting Group (2015) aggressive scenario + Acemoglu-Restrepo (2017) : employment/population ratio declines by 1.76% in next decade
- Bureau of Labor Statistics (2006): employment/population ratio declines by 2.7% based on demography in next decade
- Net: demographic effect is 53% larger than than the automation effect!
  - Tight labor markets
  - Rising wages
  - Increased incentive for employers to economize on labor
  - Increase incentive workers to provide more labor (part time, flexwork, delayed retirement)
- Suggestion
  - Estimated impact of automation should be compared to demographic realistic baseline, not a zero baseline
  - Both demand *and* supply matter!

As retirees age, they become more costly

Fact sheet: Aging in the United States

- People over 65 in US today: 46 million, 15 percent
- People over 65 in US in 2060: 98 million, 24 percent
- People with Alzheimer's today: 5 million
- People with Alzheimer's 2050: 14 million

Productivity growth in 2015:

- 1.3% productivity growth implies GDP will be 78% larger in 2060 than today
- Population over 65 doubles, Alzheimer's triples, and GDP only goes up by 78%
- If productivity growth were 1.6% we would could cover the doubling of the elderly

Harnassing automation for a future that works, McKinsey

THE END