

PROSPECTS FOR GROWTH IN THE SECOND MACHINE AGE

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MIT Initiative on the Digital Economy

<http://digital.mit.edu/erik>

DECEMBER 4, 2015

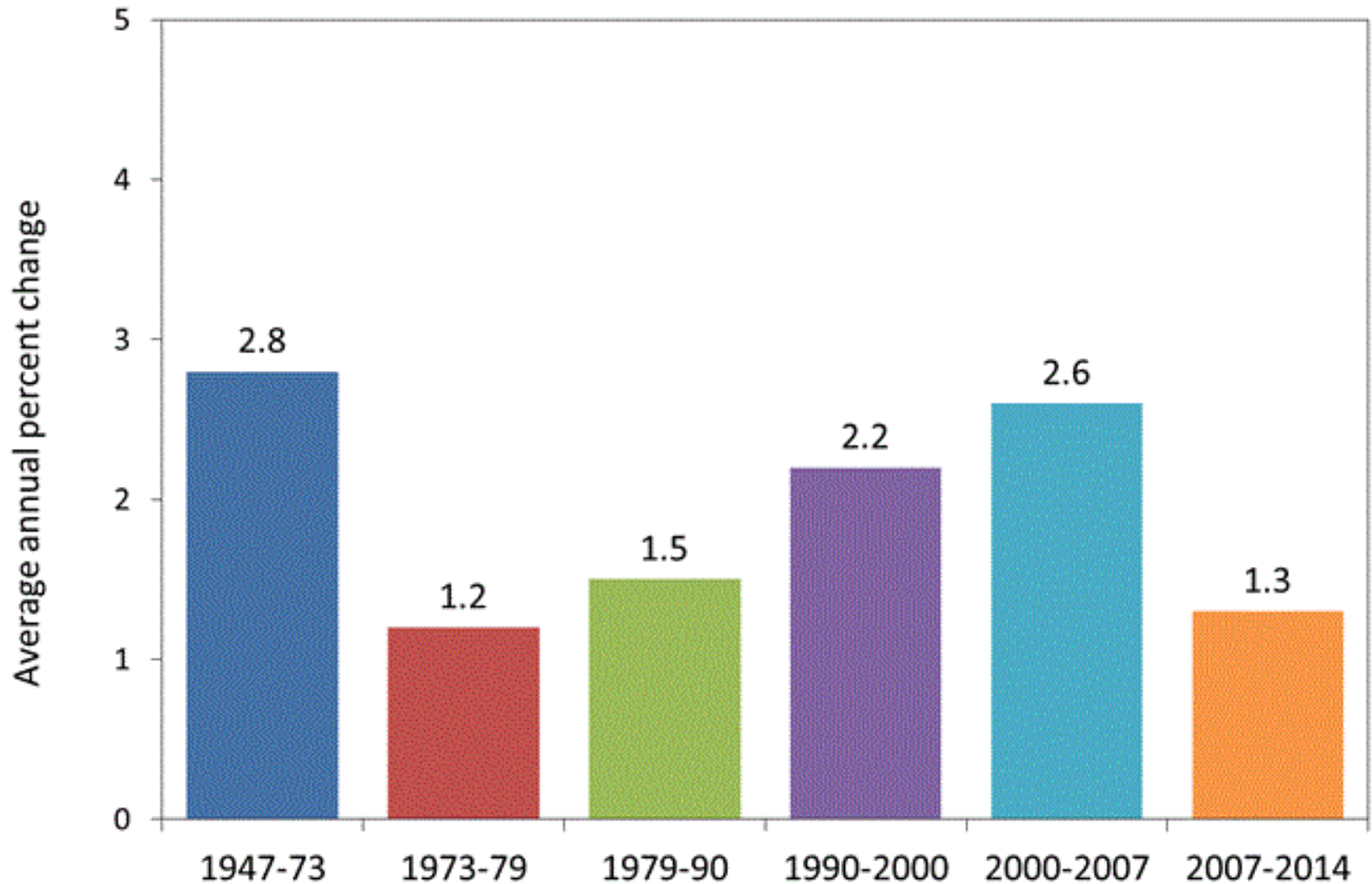
Agenda



1. What can we learn from past trends?
2. Why am I optimistic?
3. Why am I concerned?

Productivity Growth in Recent Business Cycles

Productivity change in the nonfarm business sector, 1947-2014



Source: U.S. Bureau of Labor Statistics

The Economist

JANUARY 12TH - 18TH 2013

economist.com

Obama's controversial new men

Pressure for change builds in China

Men close the longevity gap

The ghastly gurus of personal finance

Microchipping your children

**Will we ever
invent anything this
useful again?**



The growing debate about
dwindling innovation

The End of Growth?

“We are passing, so to speak, over a divide which separates the great era of growth and expansion of the [last] century...”

- Alvin Hansen, 1938 AEA Presidential address on Secular Stagnation

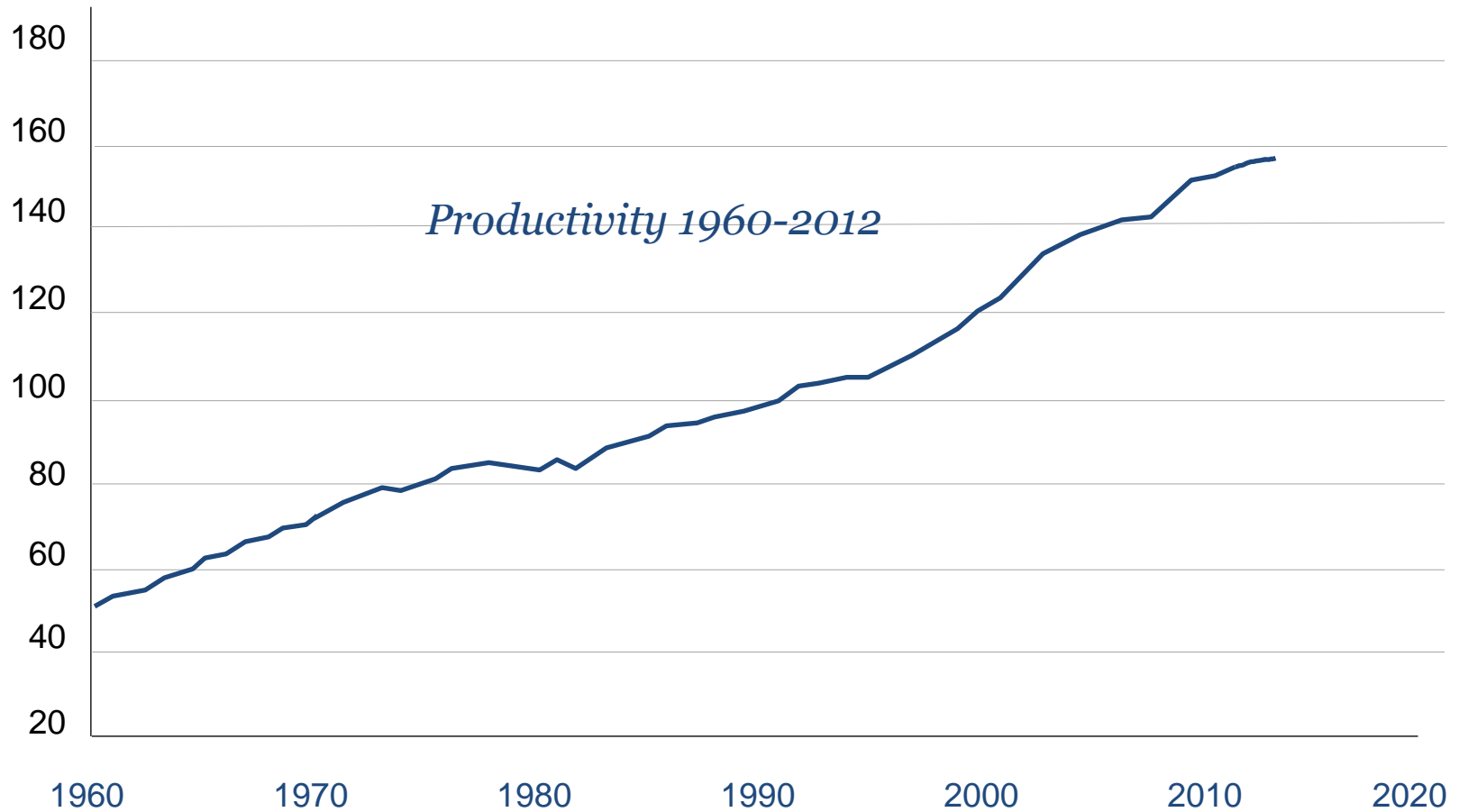
“The basic changes going on since the beginning of the century are not only important in explaining the unprecedented severity and persistence of the Great [Recession] but also in appraising the outlook for the future.

The reduced rate of growth, with respect to both population and territory, is likely to be permanent. ... This is the basis on which the stagnation school predicts a long-run deficiency of investing opportunity.”
- Harris, 1943

Technical advance... has not since early in the century produced anything to equal in scope the development of the railroad, the telephone, electric power or the automobile.

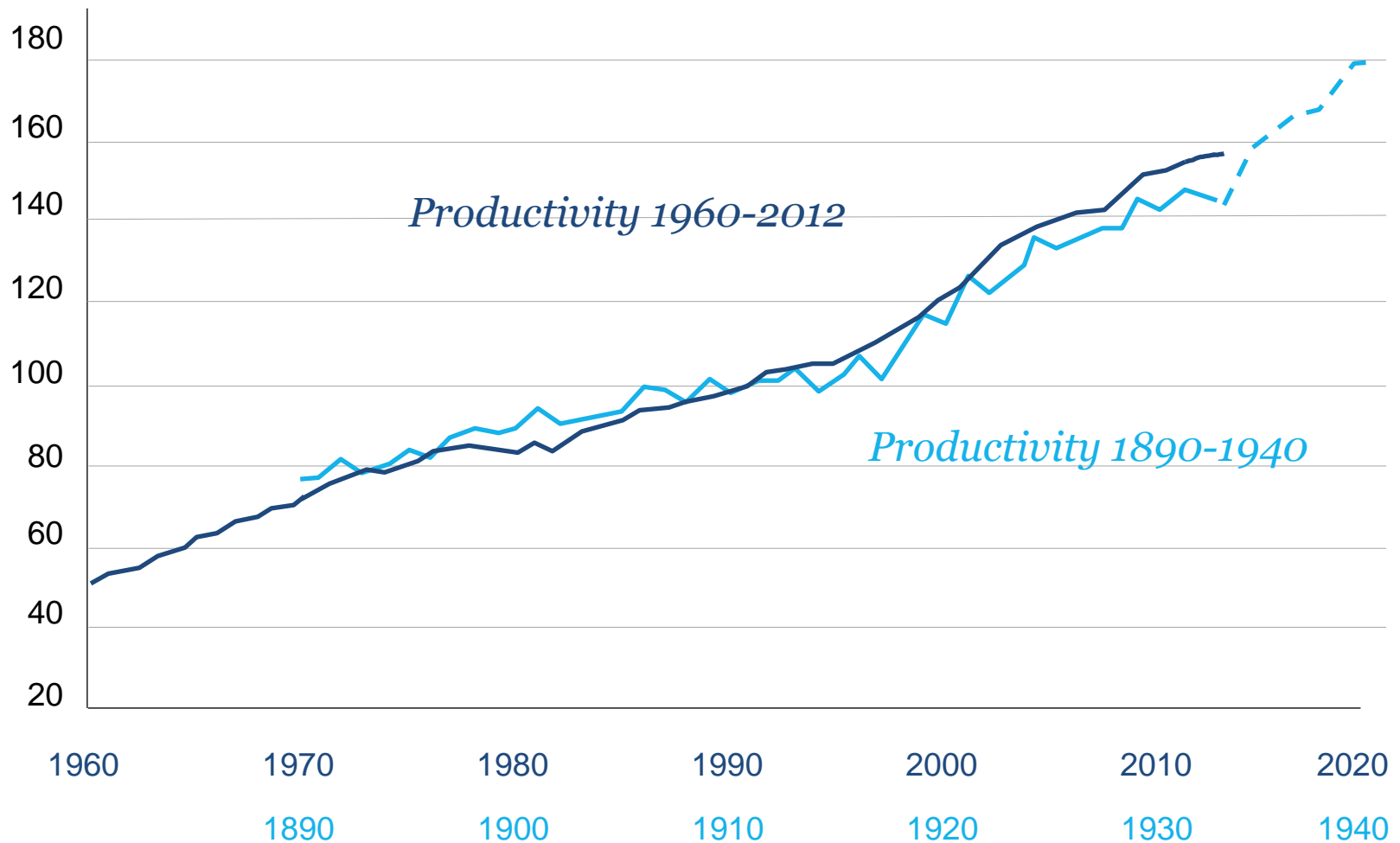
- Alvin Hansen, 1941

Labor Productivity in Two Eras



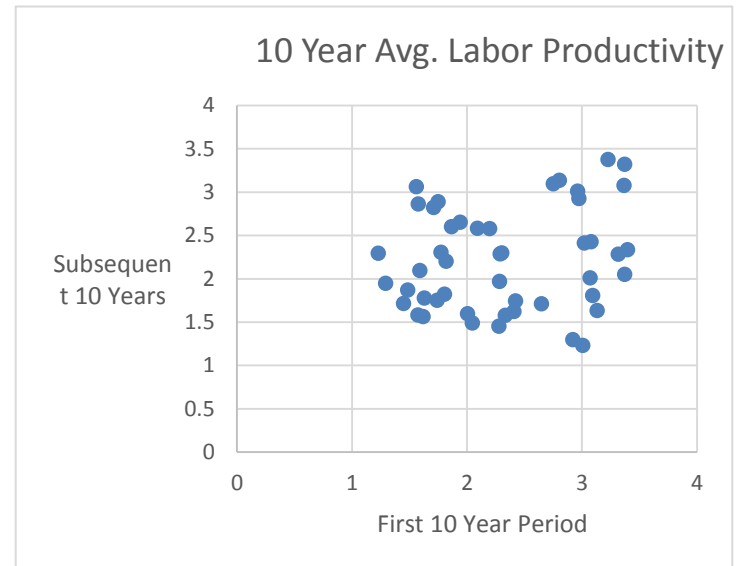
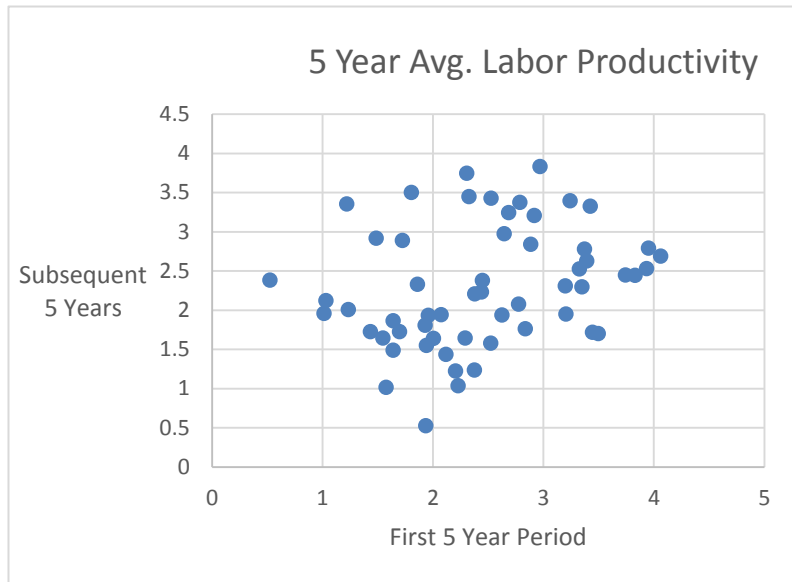
Based on Data from Chad Syverson and US Bureau of Labor Statistics

Labor Productivity in Two Eras



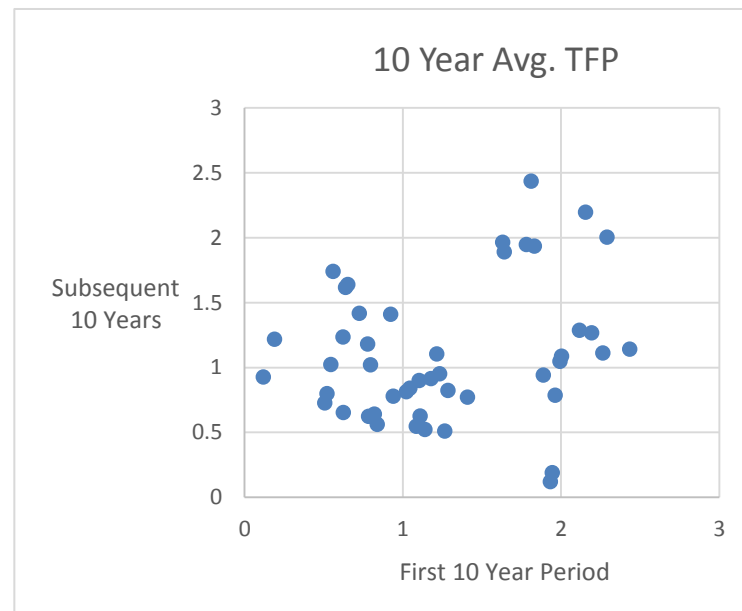
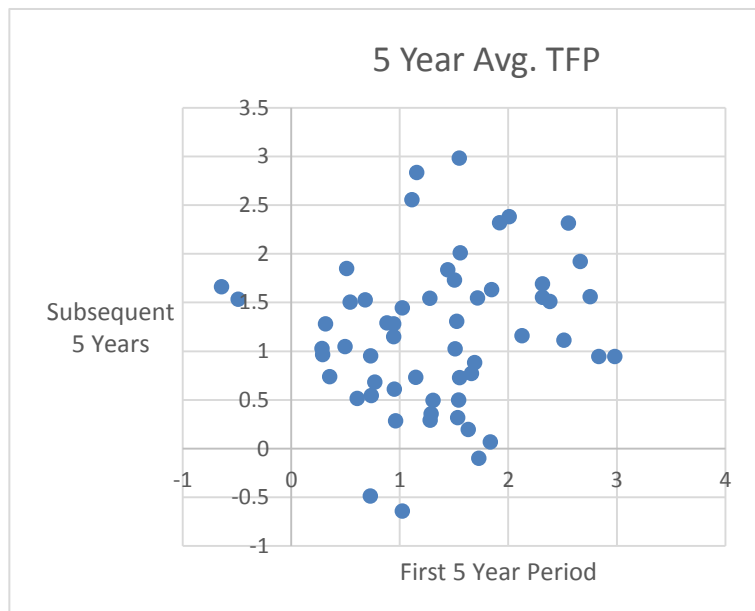
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“A Measure of Our Ignorance”



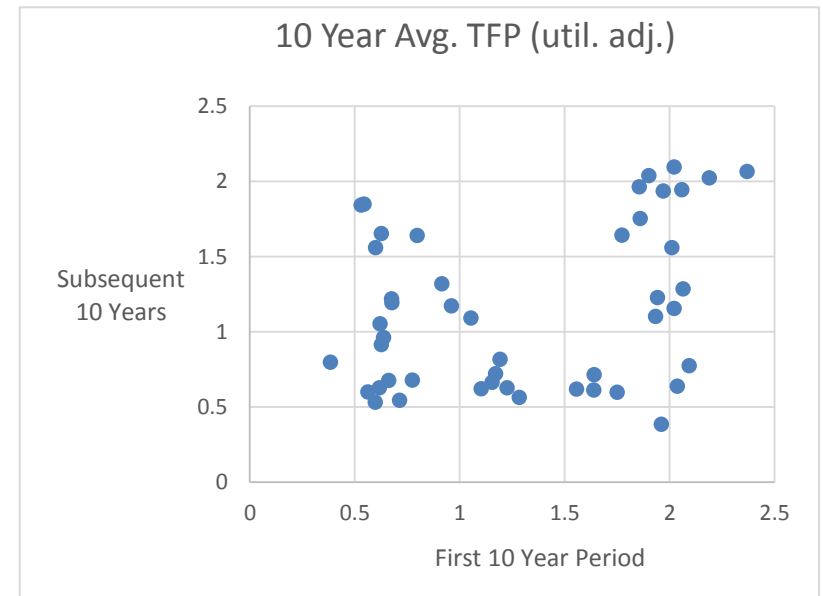
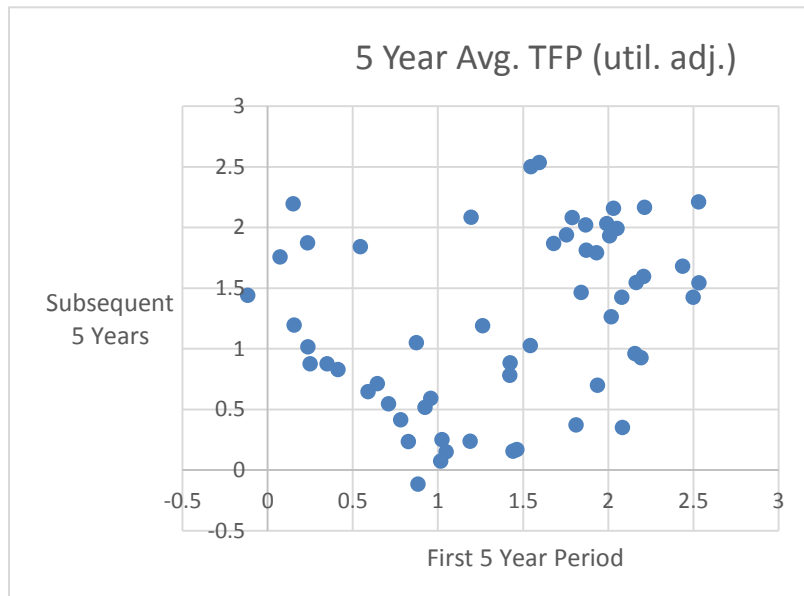
Labor Productivity

“A Measure of Our Ignorance”



TFP

“A Measure of Our Ignorance”



Utilization-adjusted TFP

I am humble about
making predictions



It's difficult to make predictions,
especially about the future
- *Neils Bohr*

What about looking directly at innovations already in the pipeline?

Economist aren't always great at assessing new technologies:

“By 2005 or so, it will become clear that the Internet's impact on the economy has been no greater than the fax machine's”

- *Economics Nobel Prize winner (1998)*

Growth in The Second Machine Age

Growth requires change

Changing the world requires two things:

- *Power system*: move or transform things
- *Control system*: decide where and how

Industrial Revolution = Physical Power

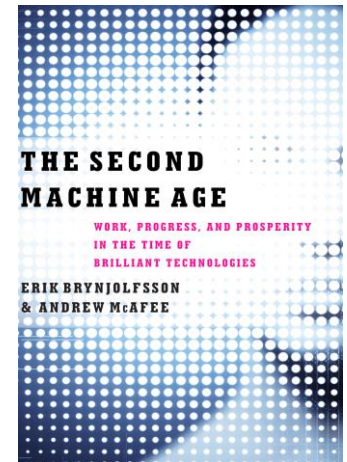
- Steam engine (and Internal combustion engine, Electricity)
- Mostly a complement to humans

Second Machine Age = Mental Power

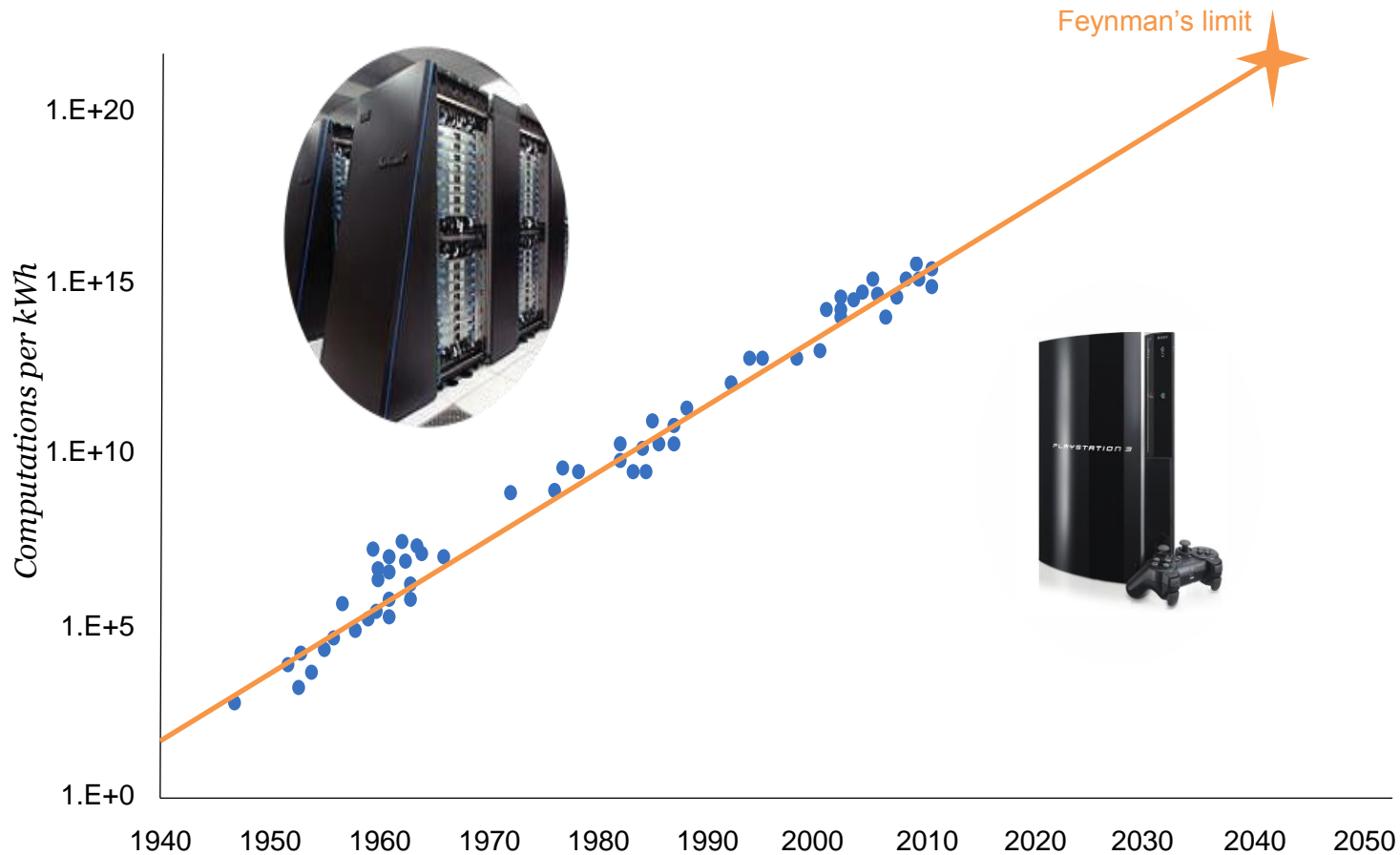
- Computers, Software, Big Data, Machine Intelligence
- Complement or substitute?

My assessment:

Machine intelligence may be our ultimate invention



Exponential (with impressive exponents)



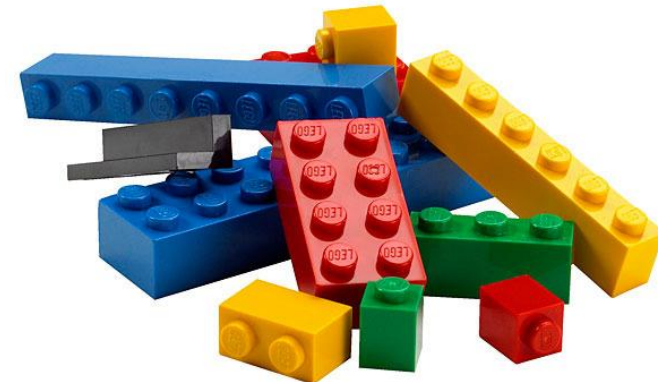
Source: Jonathan Koomey

Digital

[illegible]

Combinatorial

- Innovations don't get used up, they multiply
 - Every time we invent something, we make it easier to invent something else
- More brains connected to global network → more innovation
 - Not just accessing world's knowledge, but adding to it
- Not just more brains, more building blocks to work with
 - More and more of them are free, perfect and instant





Michael Plazmeyer So I am going to drop 15.279 as it conflicts; so this semester: 6.01, 6.041, 14.015.501, 15.567 7 hours ago clear

Wall

Info

Photos

GridView

4Change

Boxes

+

[Invite](#)
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I am an MIT management major in my second year. My site is <http://plazmeyer.com/>



Humans vs. Machines in 2005 to 2015:

3 Big Changes:

1. Interacting with physical world
 - Fine and gross motor control
 - Vision and other senses
2. Language
 - Voice recognition
 - Natural language processing
 - Creating narratives
3. Problem Solving
 - Answering unstructured questions
 - Rule based analysis
 - Pattern recognition and classification



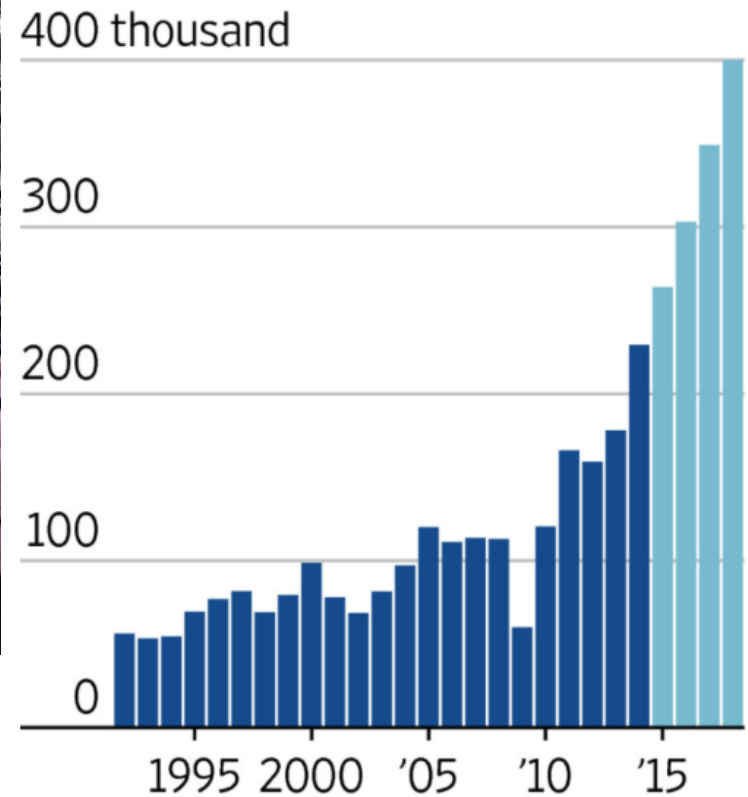




The Robot Revolution has Barely Begun



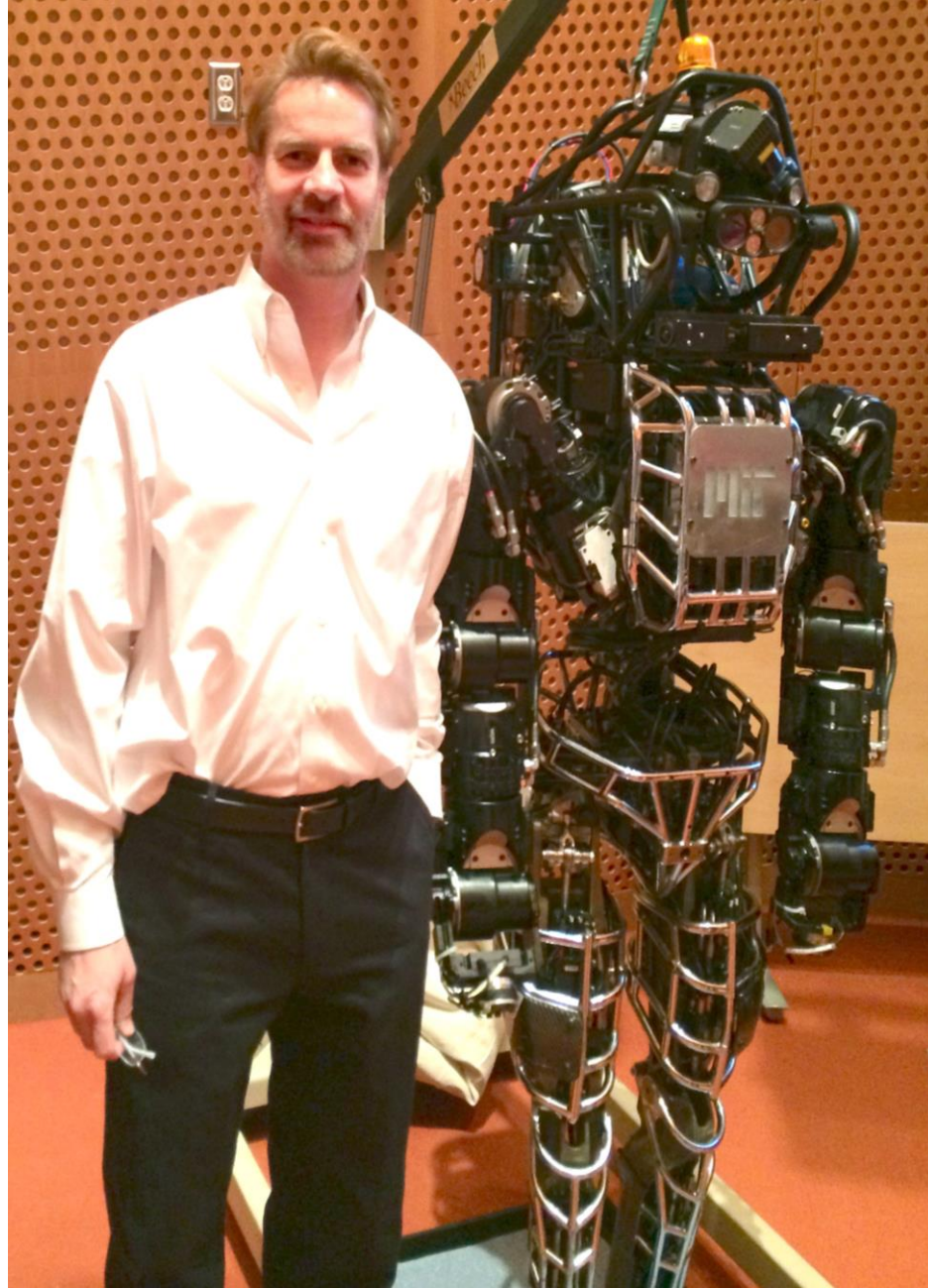
World-wide industrial robot shipments



Note: 2015 and later are projections.

Source: International Federation of Robotics





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Siri

Voice recognition



Skype

Real time
Translation



Automated Insights

Authoring News Stories



Writing Articles

The Times beats Street 4Q forecasts

New York Times Co. tops 4Q net income and revenue expectations

AP February 3, 2015 8:48 AM



NEW YORK (AP) _ The New York Times Co. (NYT) on Tuesday reported fourth-quarter net income of \$34.9 million.

The New York-based company said it had profit of 22 cents per share. Earnings, adjusted for one-time gains and costs, came to 26 cents per share.

The results exceeded Wall Street expectations. The average estimate of analysts surveyed by Zacks Investment Research was for earnings of 23 cents per share.



Related Stories

The newspaper publisher posted revenue of \$444.7 million in the period, also topping Street forecasts. Analysts expected \$437.2 million, according to Zacks.

For the year, the company reported profit of \$33.3 million, or 20 cents per share. Revenue was reported as \$1.59 billion.

The Times shares have dropped 3.5 percent since the beginning of the year. The stock has declined roughly 10 percent in the last 12 months.

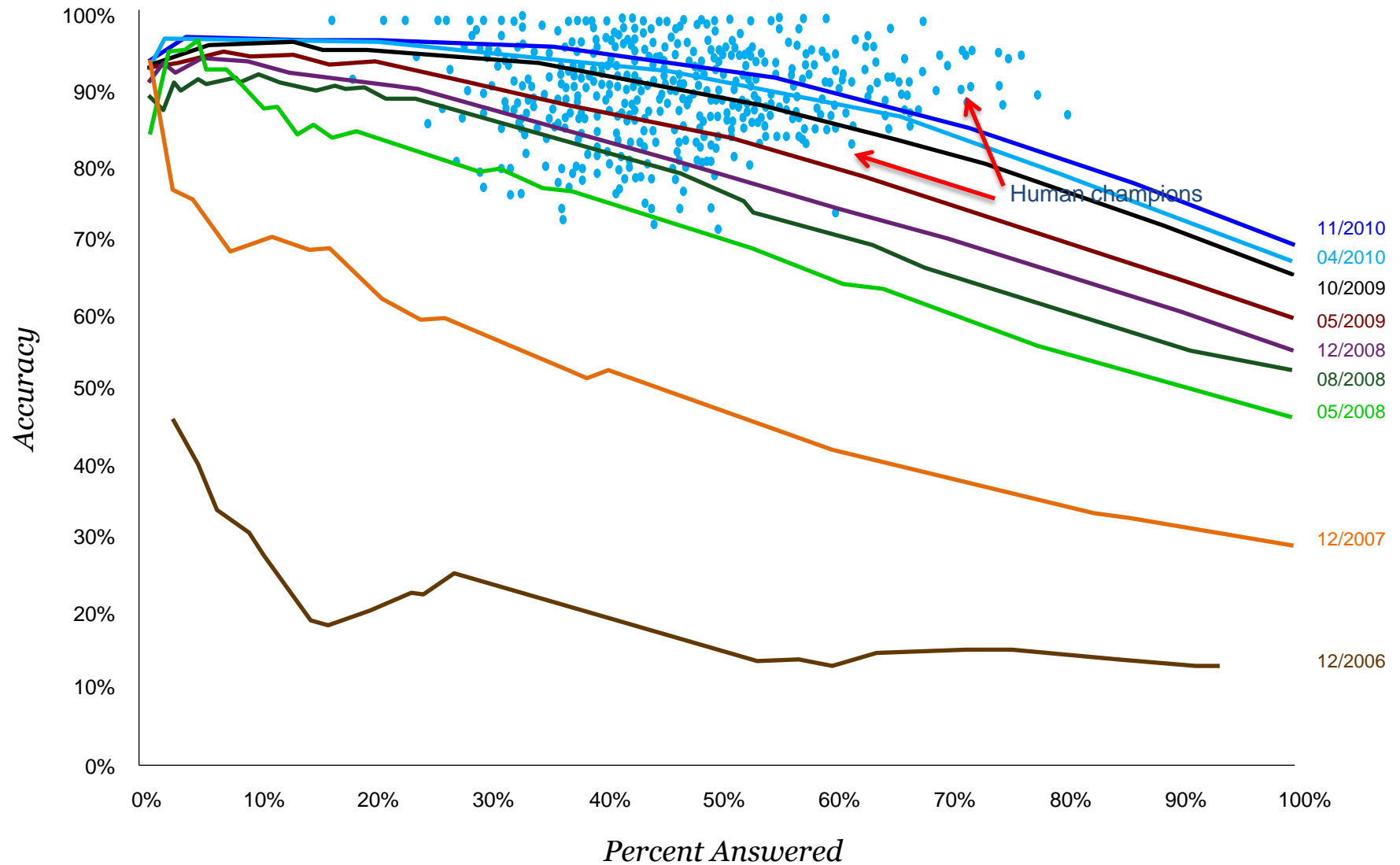
This story was generated by Automated Insights (<http://automatedinsights.com/ap>) using data from Zacks Investment Research. Access a Zacks stock report on NYT at <http://www.zacks.com/ap/NYT>

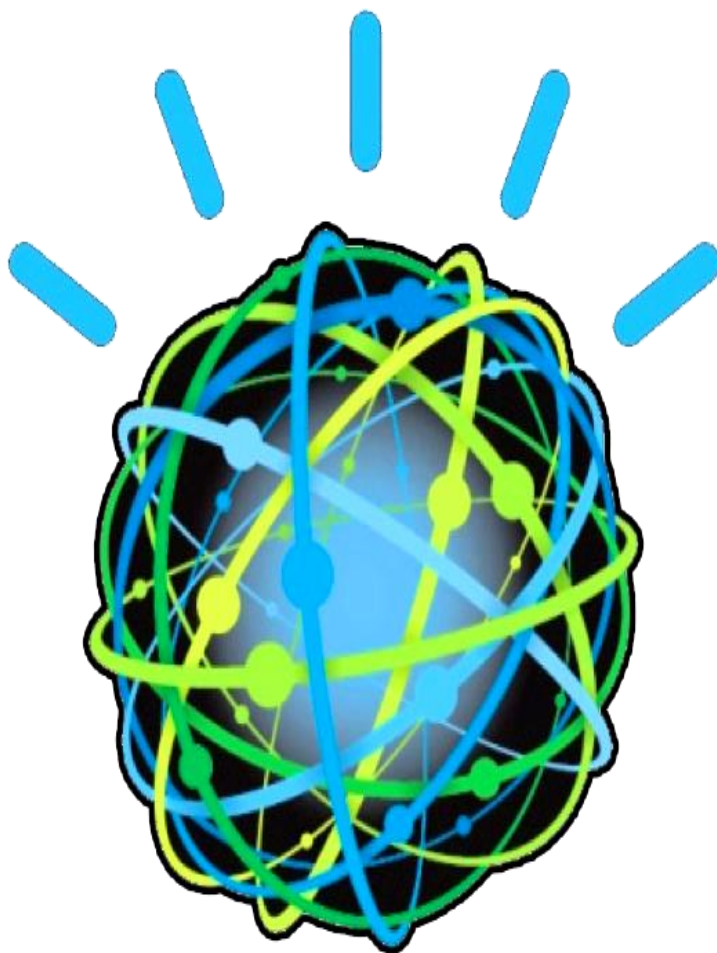
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Accuracy and Questions Answered on *Jeopardy!*





SMARTER THAN YOU THINK

Armies of Expensive Lawyers, Replaced by Cheaper Software



Ramin Rahimian for The New York Times

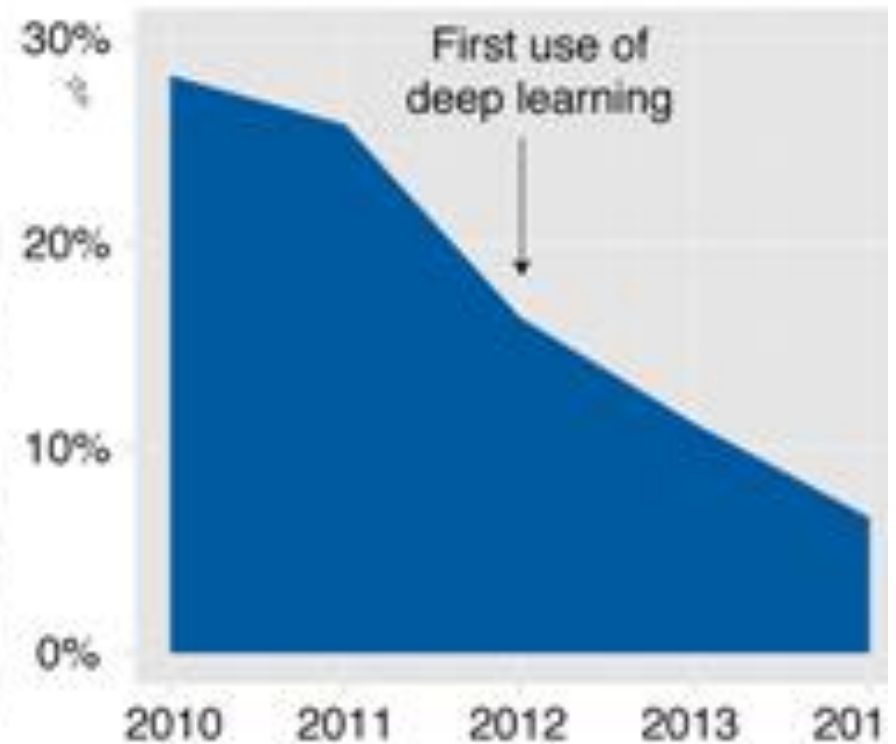
"People get bored, people get headaches. Computers don't," said Bill Herr, a lawyer who used to work for a chemical company.

Improvements in Vision

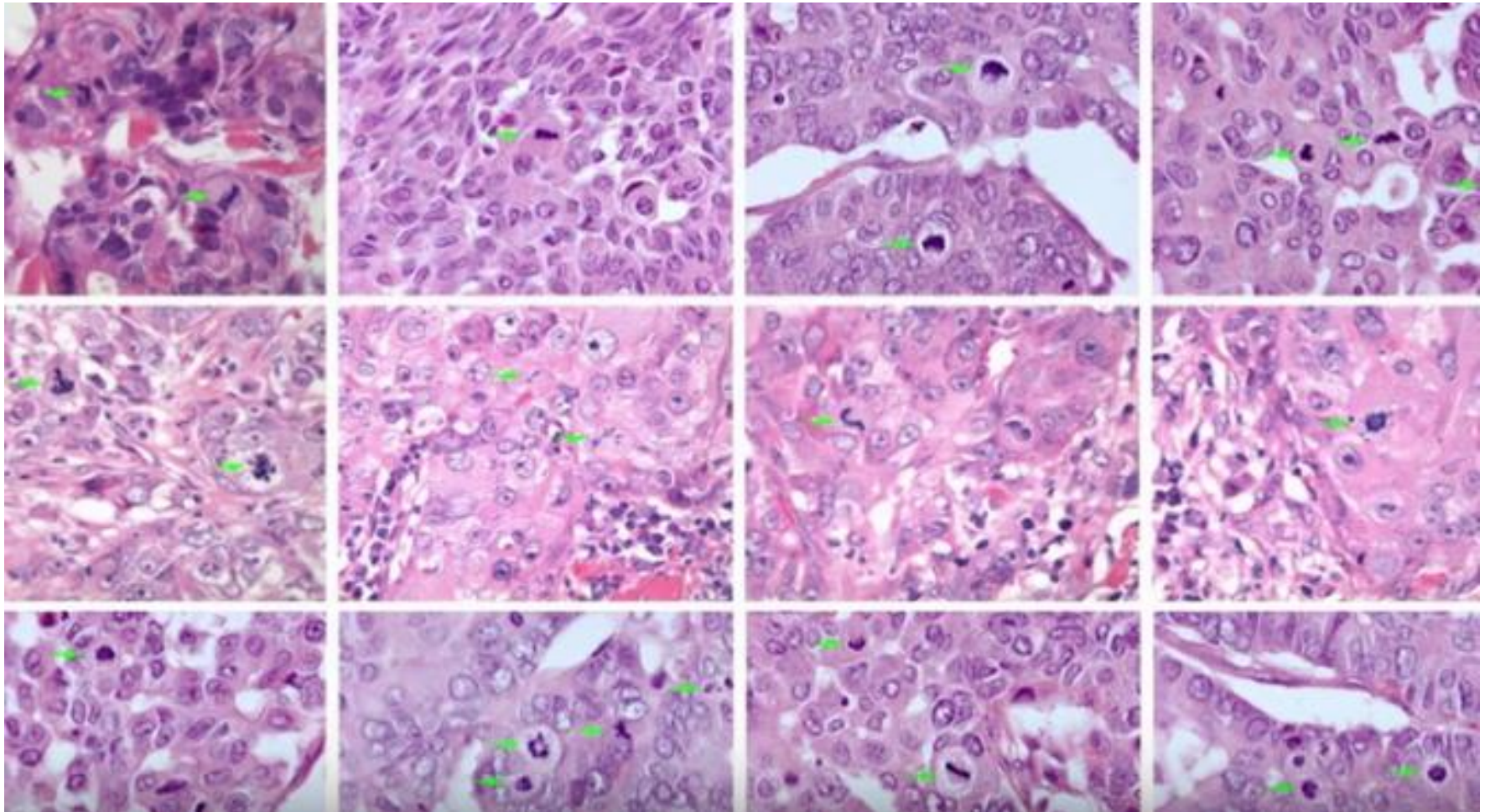
ImageNet examples



Object classification error rate



Enlitic Detects Cancer



I'm concerned about whether our
organizations and institutions can keep up...

Computerization > Computers

IT Capital (10%)

**Technological
Complements (15%)**

**Organizational
Complements (75%)**

Intangible Assets
*are more important in
the Information Economy*

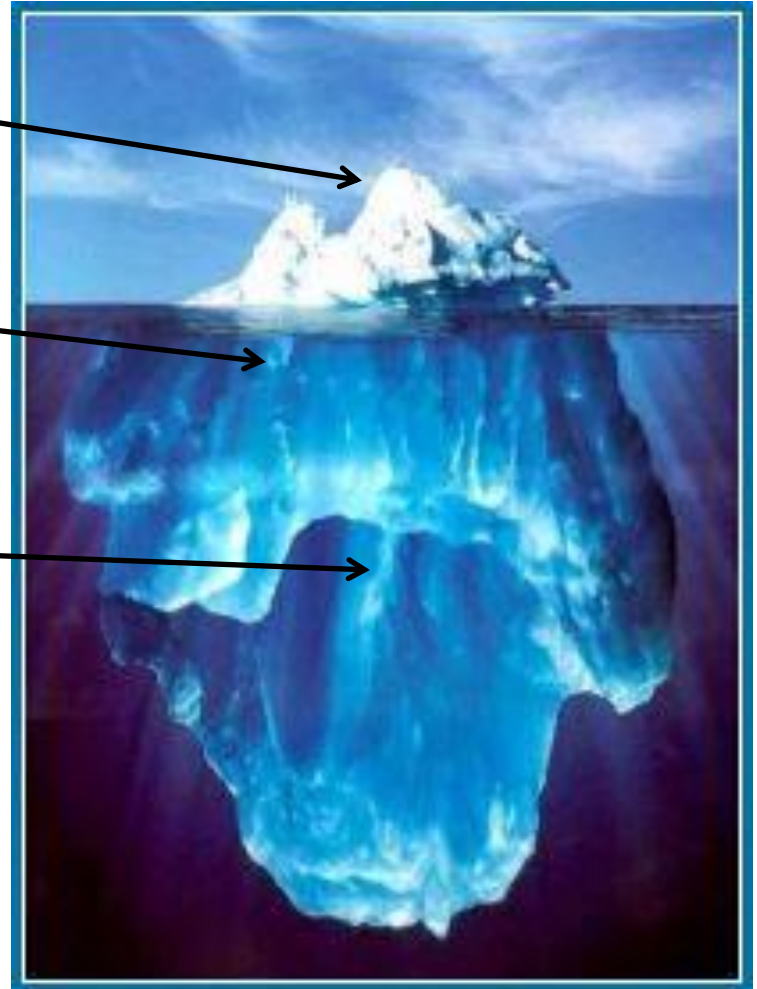
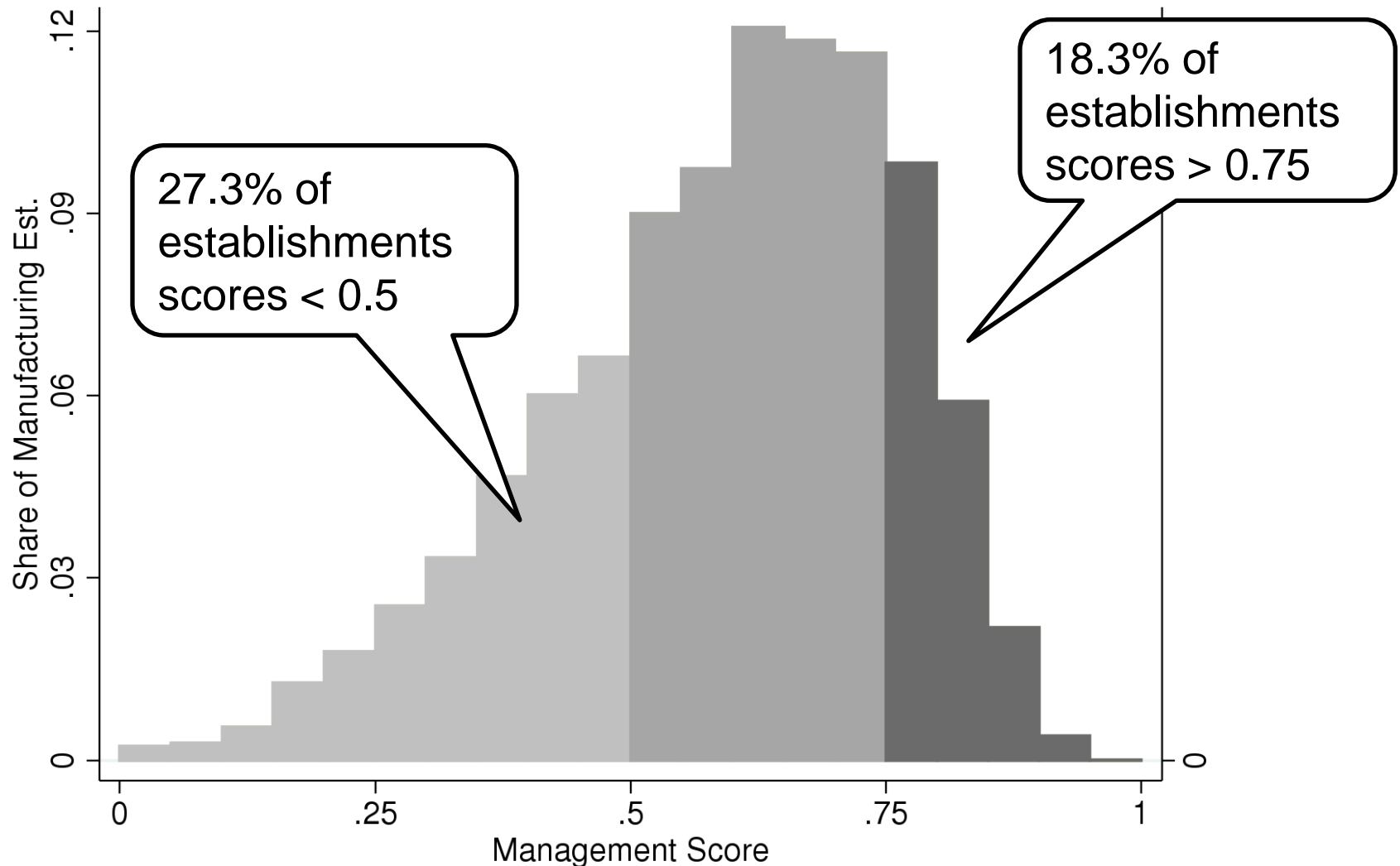


Image by Ralph Clevenger

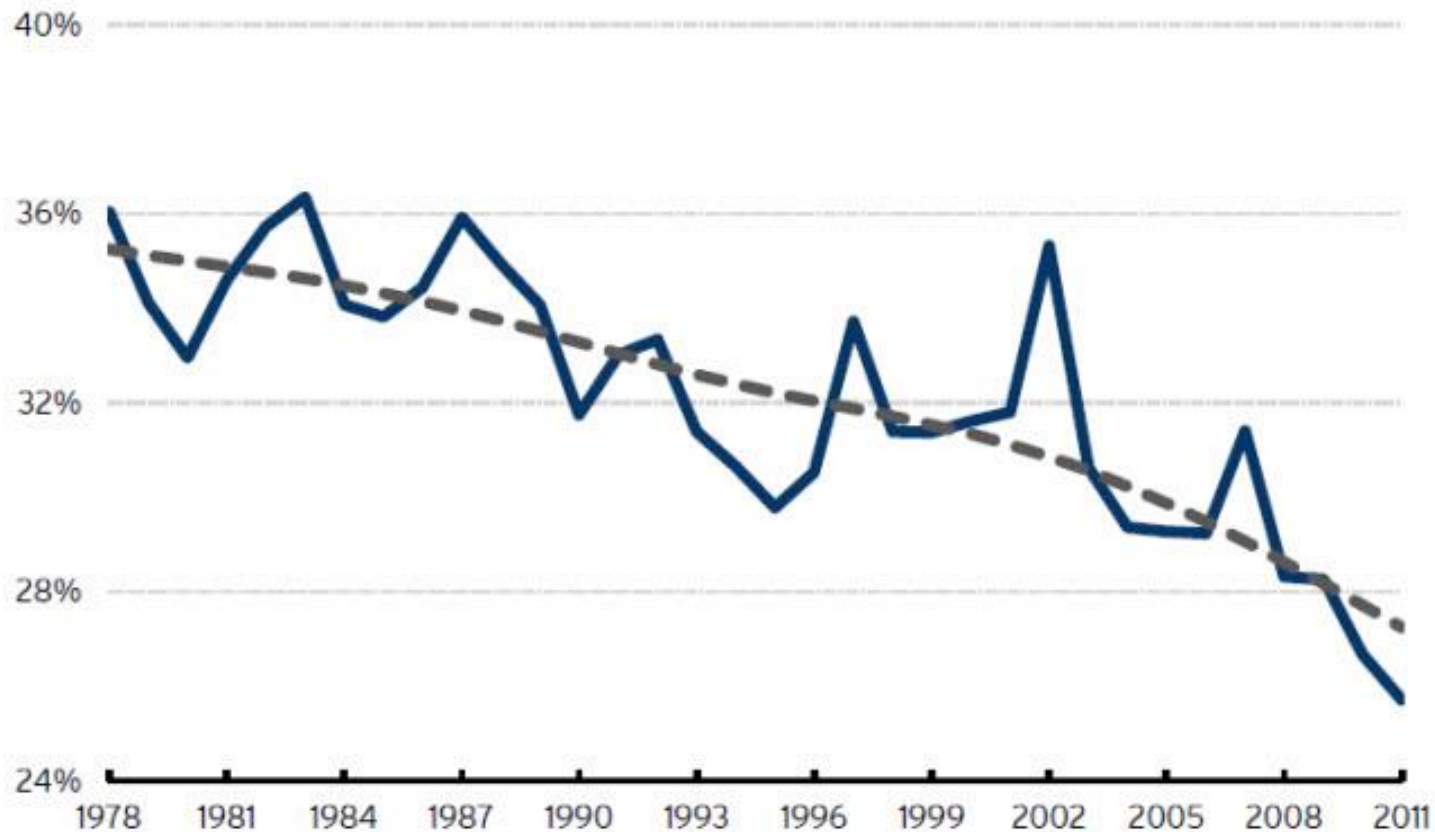
There is a very wide spread of the adoption of management best practices in the US



Source: Bloom, Brynjolfsson et al. *Management In America*, 2013

Figure 2.

Business dynamism has been steadily declining over the last three decades
Job Reallocation Rate and Trend, 1978-2011



Source: U.S. Census Bureau, BDS; authors' calculations
Note: Trend is calculated by applying a Hodrick-Prescott
filter with a multiplier of 400

The Hard Truth

Erik Brynjolfsson
Andrew McAfee

Race Against The Machine

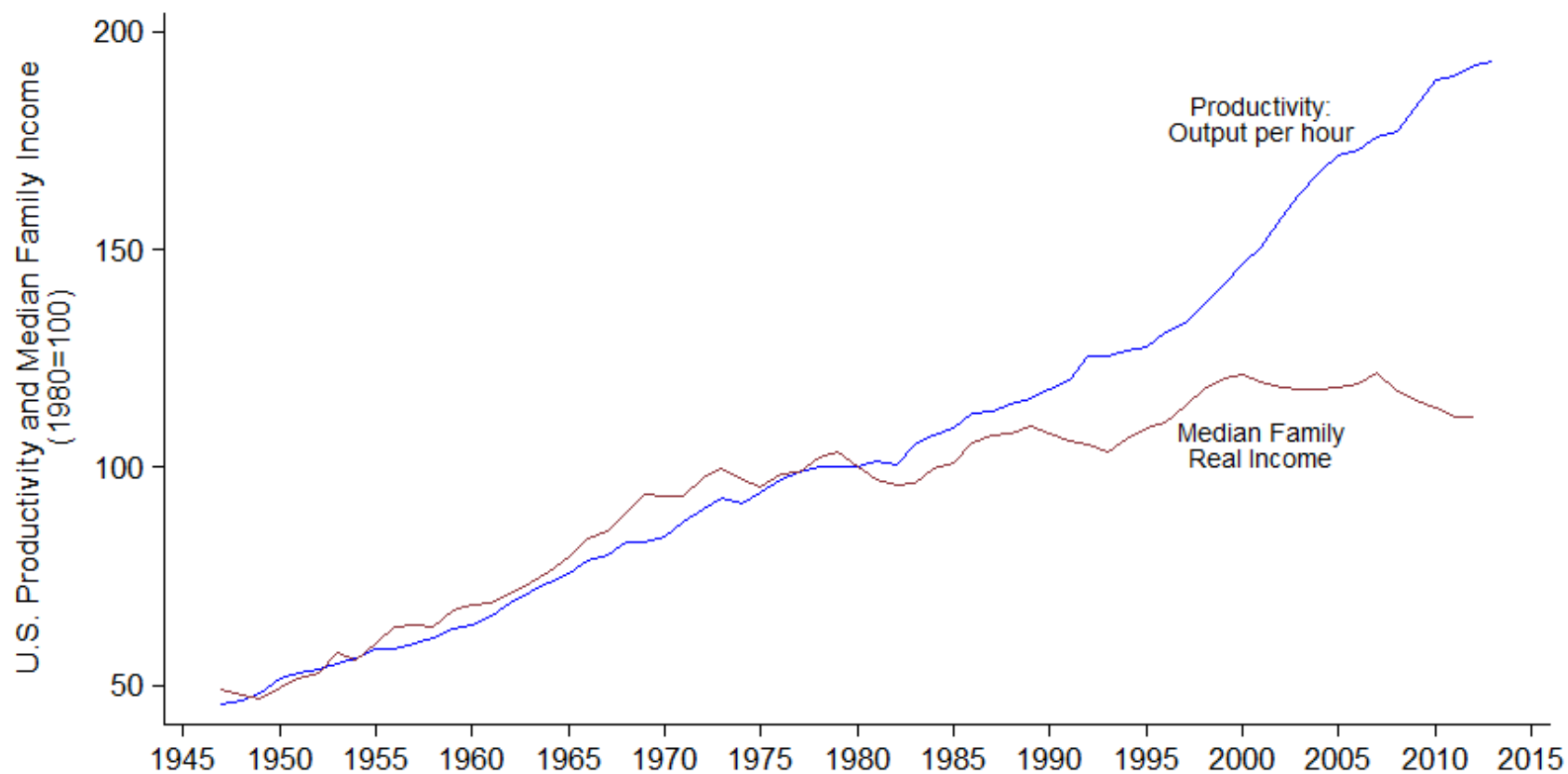


How the Digital Revolution is Accelerating Innovation,
Driving Productivity, and Irreversibly Transforming
Employment and the Economy

Digital progress makes the economic pie bigger.

But there is no economic law that everyone, or even most people, will benefit.

Productivity isn't everything



Source: BLS, CPS

The New Grand Challenge

- Digital technologies will continue to accelerate.
 - Our skills, organizations and institutions are lagging.
 - Business as usual won't solve this problem.
- *We need to reinvent our organization and institutions to keep up with accelerating technology*