

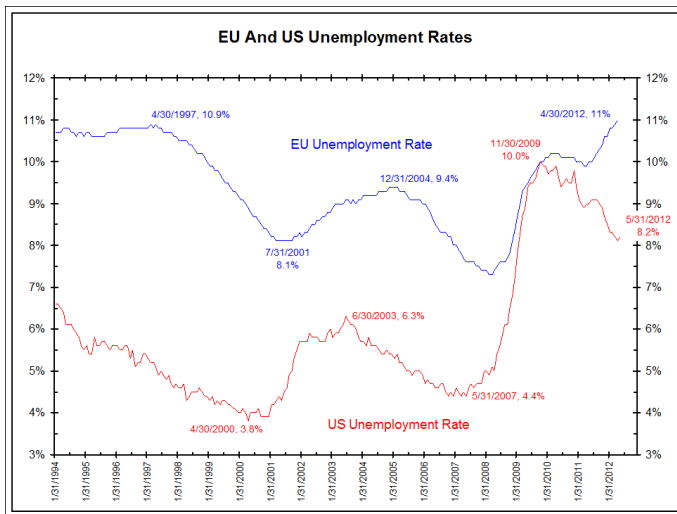
The Labor Market Impact of Technology: Past, Present and Future

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CEMFI Madrid

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The Unemployment Crisis



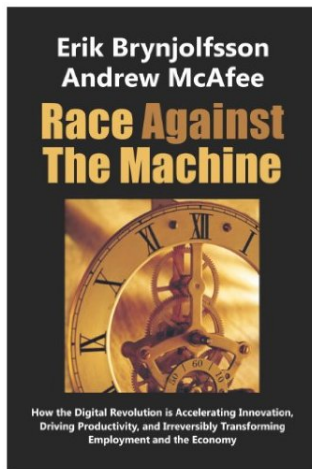
Outline

① Technology and Jobs

- **Future:** What are economists' long-term predictions about technological change?
- **Past:** How did technology affect workers over the course of history?
- **Present:** What do we know about the labor market impacts of the ongoing “computer revolution”?

② Conclusions

Hypothesis 1: The End of Work?



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1 The accelerating pace of change ...



2 ... and exponential growth in computing power ...

Computer technology, shown here climbing dramatically by powers of 10, is now progressing more each hour than it did in its entire first 90 years

COMPUTER RANKINGS
By calculations per second per \$1,000



Analytical engine
Never fully built, Charles Babbage's invention was designed to solve computational and logical problems



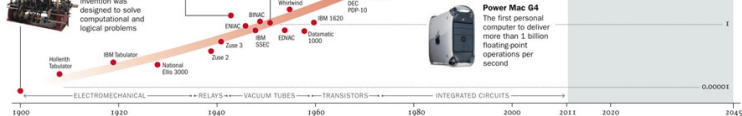
Colossus
The electronic computer, with 1,500 vacuum tubes, helped the British crack German codes during WW II



UNIVAC I
The first commercially marketed computer, used to tabulate the U.S. Census, occupied 943 cu. ft.



Apple II
At a price of \$1,298, the compact machine was one of the first massively popular personal computers



3 ... will lead to the Singularity

Source: Time Magazine

Hypothesis 2: The End of Technological Change?

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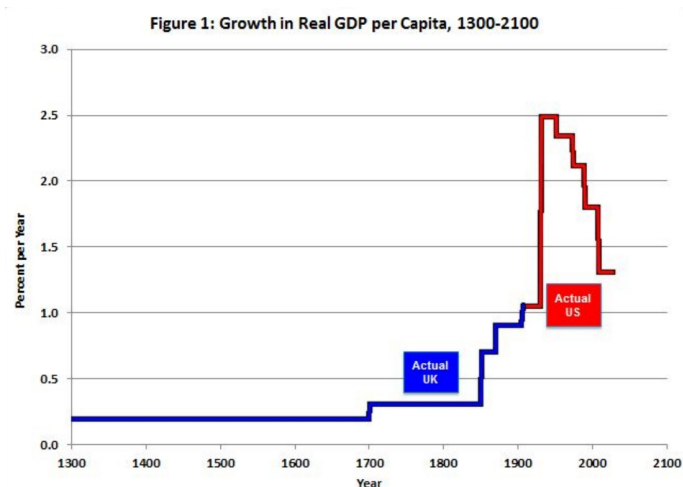
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This research has been supported by the Kauffman Foundation. Many facts and relationships highlighted here are based on my book in progress, *Beyond the Rainbow: The American Standard of Living Since the Civil War*, under contract to the Princeton University Press. To limit the scope of this short paper, only a limited number of historical references and citations are included here. All others are provided in the book manuscript. I am grateful to Marius Malkevicius and Andrew Sabene for their indispensable research assistance, and to David Warsh for helpful comments. This paper originates in a presentation that has been given to numerous audiences over the past year, and I am grateful to members of those audiences for asking provocative questions and making helpful suggestions in the Q&A sessions. The views expressed herein are those of the author and do not necessarily reflect the views of the National Bureau of Economic Research.

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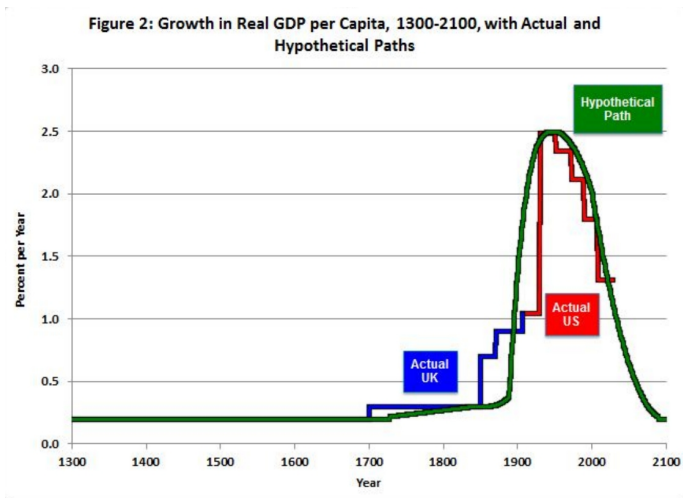
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Hypothesis 2: The End of Technological Change?



Source: Gordon (2012)

Hypothesis 2: The End of Technological Change?



Source: Gordon (2012)

A Clash of Predictions

- Speculative predictions about future technological change vary dramatically:
 - 1 An ever accelerating improvement of computer technology will rapidly lead us to the point where computers dominate most human labor.
 - 2 There is decreasing scope for future innovation, and technology will have little novel impact on labor markets in the future.

From Speculation to Evidence

- We can only speculate about the distant future. However, we have empirical evidence about past experience with technology:
 - ① What labor market effects of technology did people expect?
 - ② What were the actual impacts?
- I will discuss historical technological progress using examples from the textile sector.

Technology 1: Hand Spindle



Source: Wikipedia

Technology 2: Spinning Wheel (11th-15th Century)



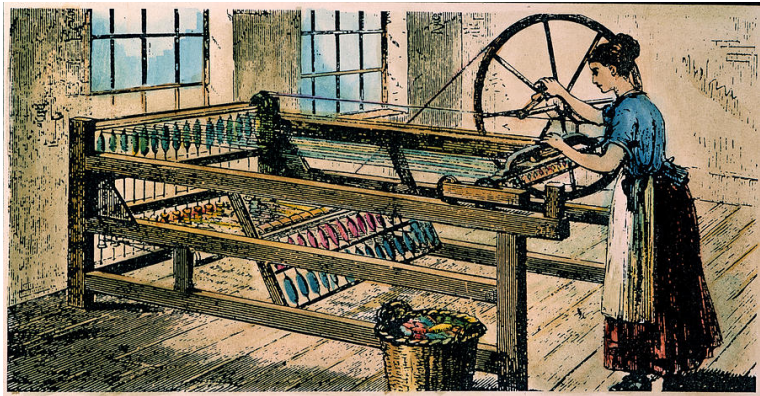
Source: Wikipedia

Reaction to the Spinning Wheel: Bans

- In 1412, the city council of Cologne prohibited the production of a spinning wheel by a local craftsman because it feared unemployment among textile manufacturers that used the hand spindle.
- In the 16th Century, the newly developed ribbon weaving machines were banned in large parts of Europe.

Source: Prion (1907)

Technology 3: Spinning Machine (18th Century)



Source: AP European History

Reaction to the Spinning Machine: Protests



Source: Wikipedia

Labor Market Impact of Technological Innovation

- The spinning machine allowed that one worker produced the amount of yarn previously produced by 200 workers
- Nevertheless, technological progress did not induce a long-term rise in unemployment!
- Why?
 - ① Creation of new jobs in the “technology sector” (e.g., production of machines)
 - ② Falling price of textile allowed consumers to buy more textiles and other goods, thus creating job growth in many sectors of the economy

The Luddite Fallacy

- Predictions of technology-induced long-term unemployment have been proven wrong time and again.
- The amount and composition of work in the economy is not fixed: While there is ongoing mechanization of jobs, there is also ongoing creation of new employment opportunities.
- At the start of the 20th Century, few would have predicted that today, employment in banks or hospitals or in the entertainment industry exceeds employment of the entire agricultural sector.

The Computer Revolution



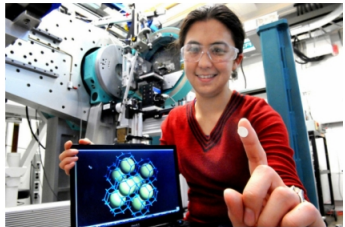
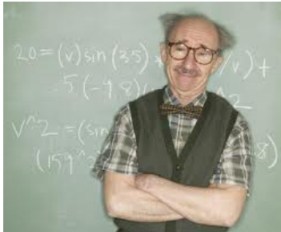
What Do Computers Do?

- Computers execute routines that follow exact procedural rules:
 - Saving/recalling/transmitting information
 - Calculations
 - Steering machines according to a pre-specified program
- Computers struggle with task that cannot easily be programmed ex ante:
 - Creativity
 - Social interaction (leadership, negotiations, coaching)
 - Visual and spatial recognition and fine motoric movement

“Routine” Occupations Compete with Computers



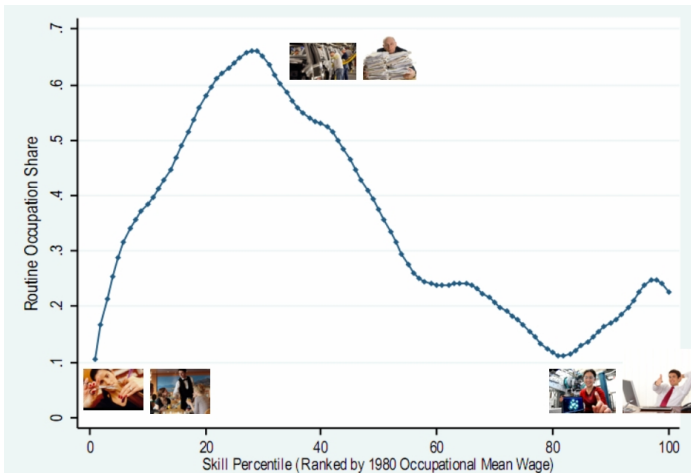
“Abstract” Occupations Benefit from Computers



“Manual” Occupations are not Directly Affected

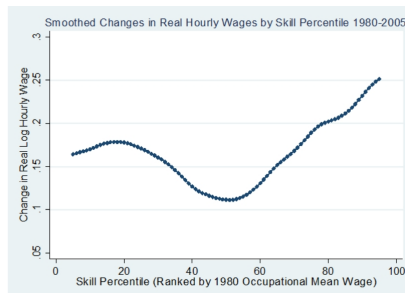
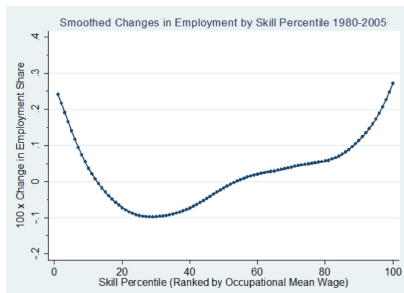


“Routine” Occupations Have Middling Wages



Source: Autor and Dorn (2013)

Labor Market Polarization: USA 1980-2005



Source: Autor and Dorn (2013)

But What About New Technologies?

- The technology frontier is continuously shifting
 - Computers are getting better at doing many tasks that could not be automated previously
 - Nevertheless, jobs with “routine” task content remain those that are most exposed to automation
- The technology frontier has also been shifting in the past
 - Maybe it’s even advancing more slowly now than in much of the 20th Century
 - In the past, the technology-induced disappearance of occupations has been compensated by the technology-induced appearance of new occupations

And What About Google Car?

- Let's remind ourselves of the self-flying airplane (from 1947)...



- Between 1950 and 2005, the fraction of US workers that are employed as airplane pilots multiplied by a factor of three.

Picture: Wikipedia

What Do We Learn from the Evidence?

- ① A long history shows that technological change (and increased trade) does not inevitably create long-term unemployment.
- ② However, these forces affect the composition of employment, as “routine” middle-wage occupations decline, and employment in low-wage “manual” and high-wage “abstract” occupations grows
- ③ Not all displaced workers can easily reallocate to new and attractive jobs.
- ④ A proactive school and training system should foster the competences that are least threatened by computerization and trade, such as creativity, problem solving, and communication.