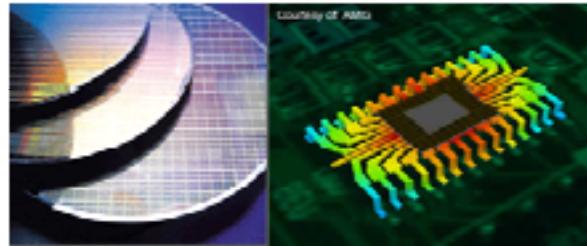




Center for the Study of Innovation and Productivity Federal Reserve Bank of San Francisco



A collage of mathematical formulas and binary code. On the left, there are three equations: $V = S N(d_1) - K e^{(r-t)} N(d_2)$, $d_1 = \frac{\ln(S/K) + (r + \sigma^2/2)t}{\sigma\sqrt{t}}$, and $d_2 = d_1 - \sigma\sqrt{t}$. To the right of the equations is a grid of binary digits (0s and 1s).



Dan Wilson

Senior Economist, FRBSF
Assistant Director, CSIP

*The views expressed here are those of the presenter and should not be attributed to the Federal Reserve Bank of San Francisco or the Federal Reserve System.

Technology Innovations: Powering or Pummeling the Economy?



- A subject of prime importance to the Federal Reserve
 - Technological change is THE key driver of productivity growth...
 - Productivity growth determines the economy's "speed limit":
 - ❖ how fast economy can grow before triggering inflation
 - ❖ higher productivity growth = lower cost per unit of output (GDP), which means lower prices, lower inflation.
 - ❖ higher productivity growth means FED can keep interest rates low while keeping lid on inflation....

Technology Innovations: Powering or Pummeling the Economy?



- Of particular importance to FRBSF
 - Recognizing critical economic importance of innovation and productivity and prevalence of innovative sectors in 12th Federal Reserve District...
 - FRBSF in 2002 founded **CSIP**:
Center for the **S**tudy of **I**nnovation and **P**roductivity
- FRBSF uniquely situated – both geographically and intellectually – to study these topics
 - Silicon Valley
 - Skills and interests of Economic Research staff



CSIP Mission and Goals

CSIP seeks to

—promote a better understanding of innovation and productivity and their links to the performance of national and regional economies and the behavior of firms and labor markets—

- Primary means of serving our mission is:
 - ❖ Supporting and Promoting Research on topics related to Innovation and Productivity

Technology Innovations: Powering or Pummeling the Economy?



What economic research – done at CSIP and elsewhere – has to say....



Economic Effects of Tech Change:

“The Good, the Bad, and the Ugly”



The Good

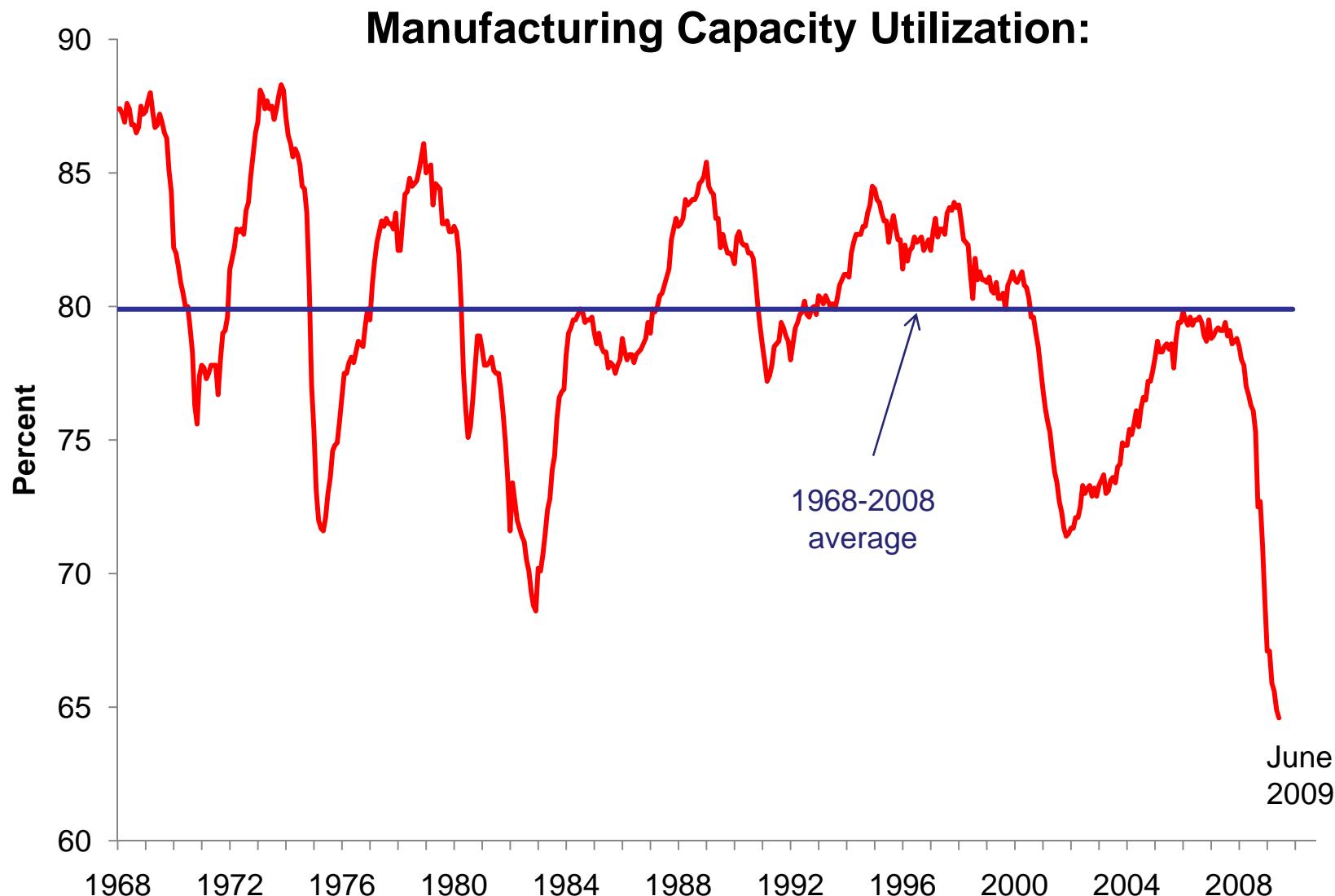
- Technological Change is THE driver of long-run growth in national output per worker (productivity growth) and therefore living standards.
 - U.S. Productivity Growth has averaged **2.5%** a year since 1949, implying a **doubling** in output per worker **every 25 years**.
 - ❖ For example, 100 years ago it took over **30** labor-hours to produce 100 bushels of corn. Today, it takes less than **3** labor-hours.
 - Real Income per capita in the U.S. was **\$7,000** in 1949. Today it is over **\$30,000**, a four-fold increase.



The Good

- Powering us through the current downturn...
 - While the main inputs into production of goods & services – labor and capital use – have plummeted over the past 18 months...
[chart 1](#), [chart 2](#)

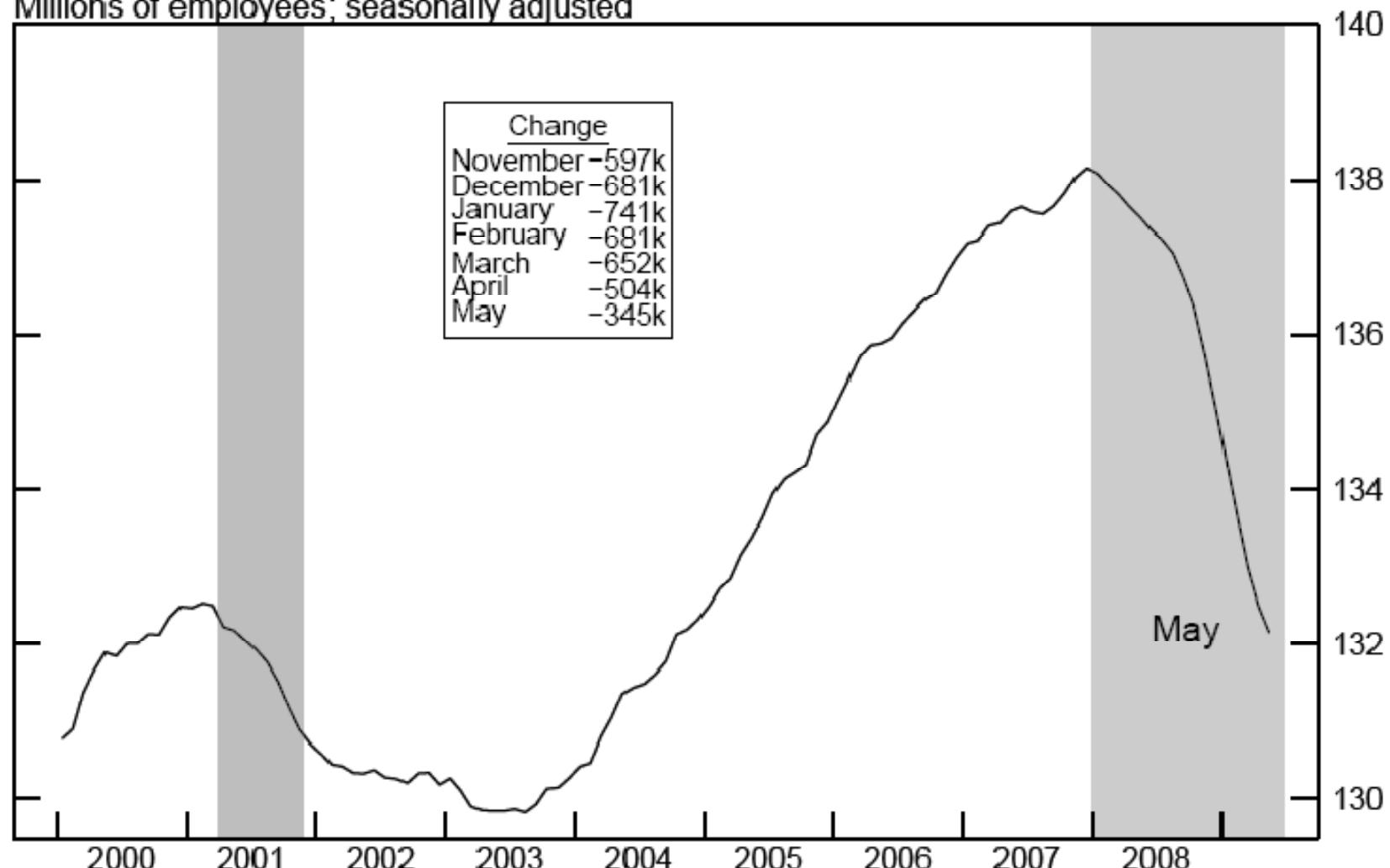
Economy's use of productive capital (Equipment, Software & Buildings) is WAY down...



Economy's use of labor also WAY down

Nonfarm Payroll Employment

Millions of employees; seasonally adjusted

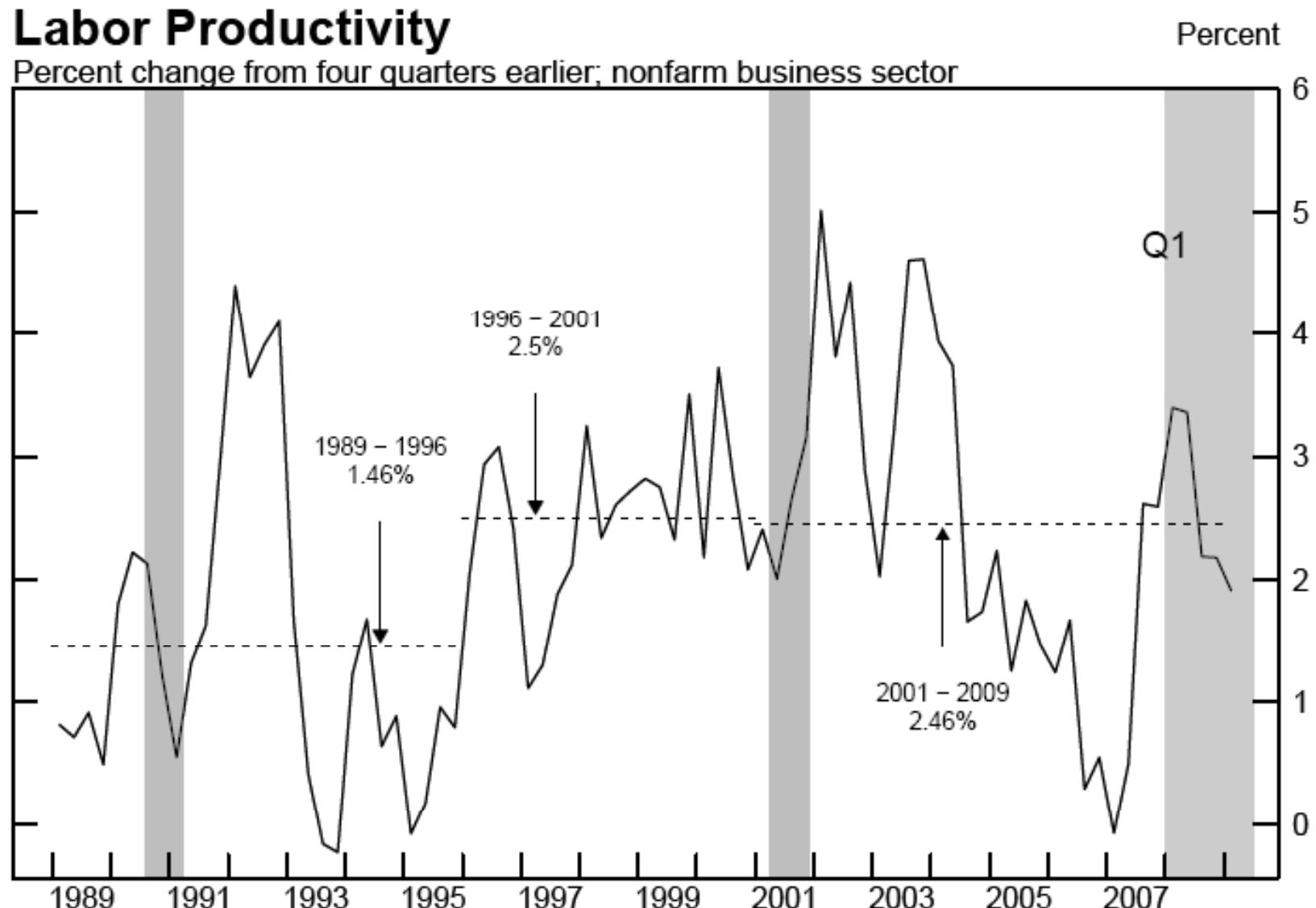




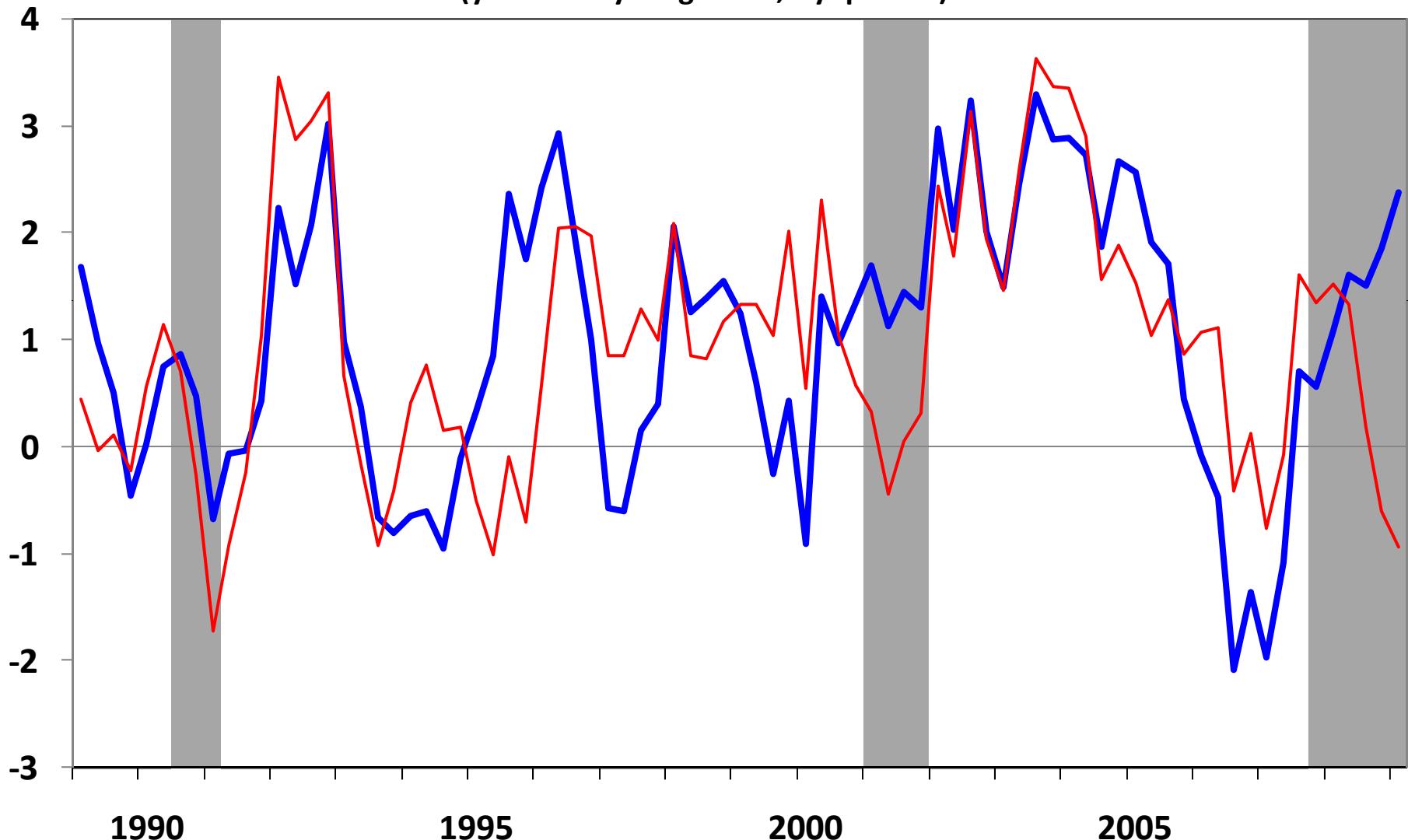
The Good

- Powering us through the current downturn...
 - While the main inputs into production of goods & services – labor and capital use – have plummeted over the past 18 months...
 - productivity growth actually has been quite strong during this recession...
(chart)

But productivity remains high...



"Total-Factor" Productivity Growth
Official (Red) vs. FRBSF Utilization-Adjusted Series (Blue)
(year-over-year growth, by quarter)



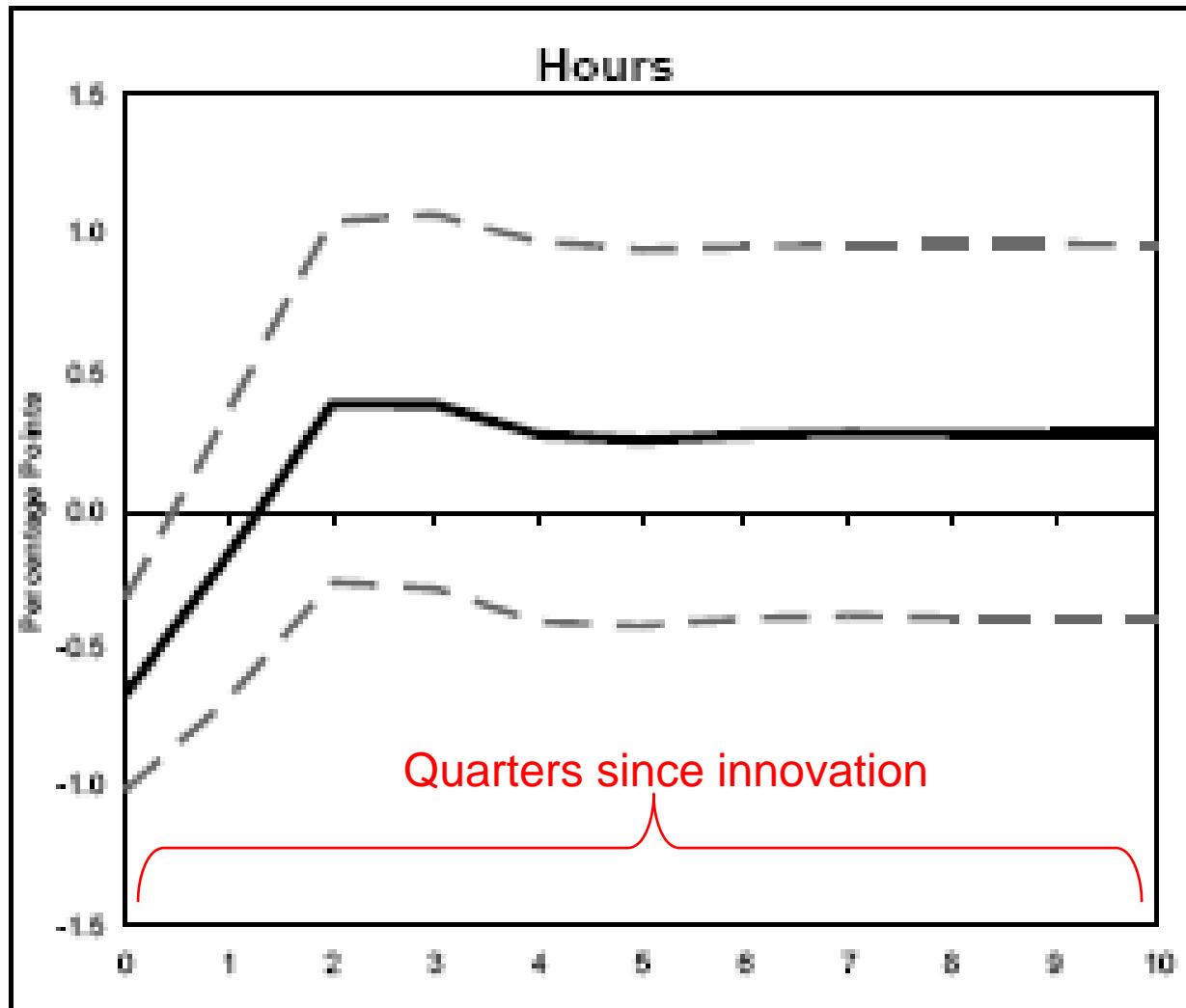
Source: John Fernald, FRBSF Vice President and CSIP Research Scholar



The Bad

- Technological Change can be disruptive in short-run, even causing job losses
 - “John Henry Effect”: Innovations allow businesses to produce more output with same labor, but flip side is they allow businesses to produce same output with less labor.
 - Recent economic research, some done here at **CSIP**, has found that past episodes of rapid technological change have led to short-run declines in employment. ([chart](#))

Estimated Response of Employment to Technology Innovations



Source: Basu, Fernald, & Kimball, *American Economic Review* (2006)

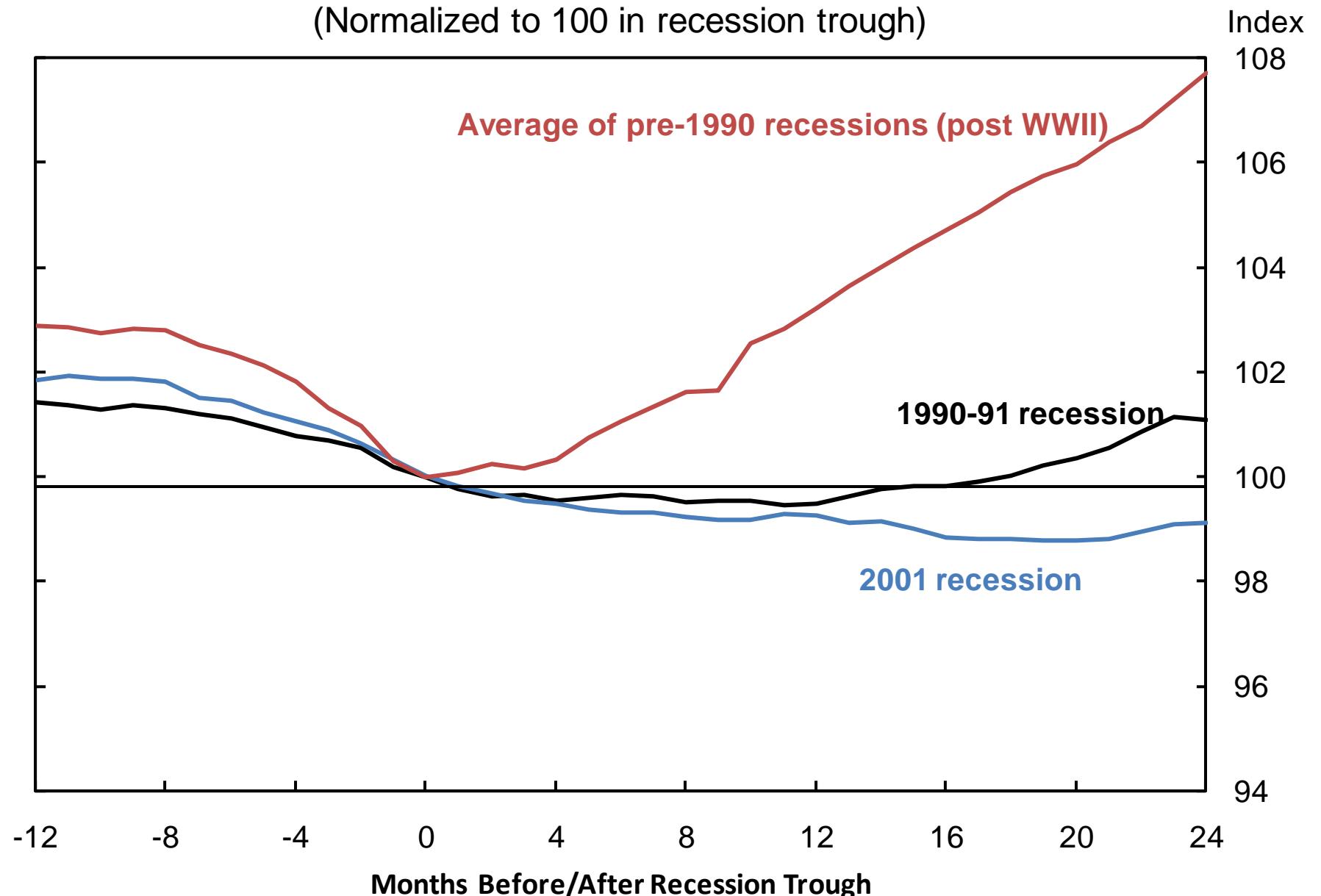


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Private nonfarm payroll employment

(Normalized to 100 in recession trough)





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 - John Henry Effect has been blamed for prolonged “jobless recovery” following previous two recessions (1991 and 2001). ([chart](#))
 - ❖ And many expect it to lead to jobless recovery following current recession (e.g., double-digit unemployment rates lasting into 2011)



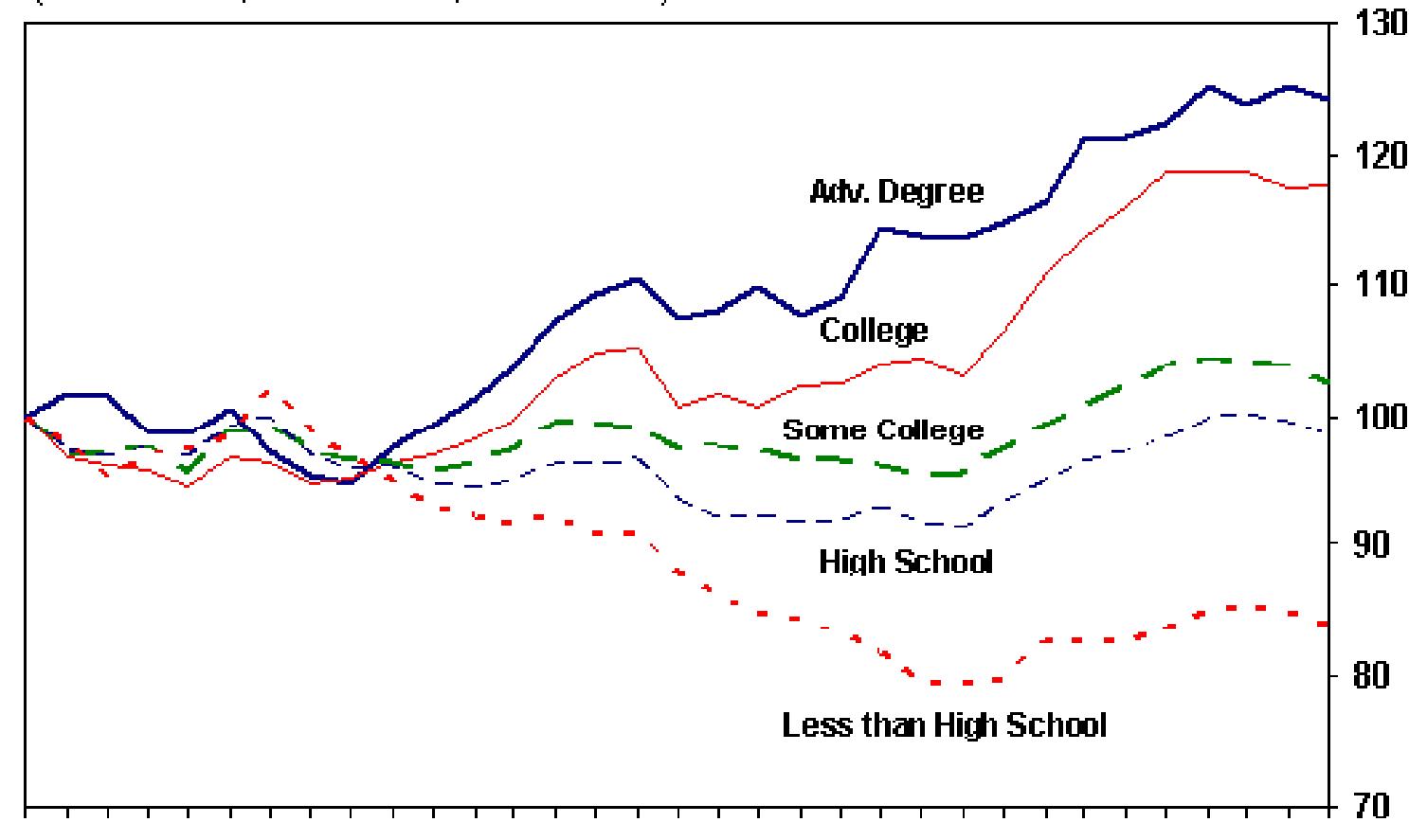
The Ugly

- While technological change is good for all in long-run, gains are not uniform
 - Relative winners and losers: U.S. income distribution has become much more highly skewed over the past 30 years.
 - ❖ In 1978, the top 1% of wage-earners accounted for **6.4%** of total U.S. earnings
 - ❖ In 2004, the top 1% accounted for **12.4%!**
*(Based on Social Security records. Kopczuk & Saez, *Quarterly Journal of Economics*, forthcoming.)*
 - Much debate about causes of this, but research has found one important factor is “**skill-biased**” technological change:
 - ❖ Notion that innovations of past 25 years (e.g., computers) have disproportionately favored high-skilled workers.
 - ❖ Evidence: Returns to education have ballooned over past 25 years ([chart](#))

Returns to education have ballooned over past 25 years

Figure 2: Real Hourly Wages by Education

(all workers, normalized; 1973=100)



Source: Economic Policy Institute

From 11/6/2006 speech by Janet Yellen, FRBSF President

Technology Innovations: Powering or Pummeling the Economy?



Short Answer: Yes!

Slightly Longer Answer:

The Good

- Technological Innovations are key driver of productivity growth in U.S., which in turn is key driver of improved living standards in recent decades...

The Bad

- But...like all changes, technological change can be disruptive, entailing short-run adjustment costs...

The Ugly

- and reshuffling of economy's winners and losers.



CSIP's Virtual Headquarters

www.frbsf.org/csip
