Future U.S. Economic Growth: Can Innovation Save Us from the Headwinds?

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The Slowdown In U.S. Growth
How Much and Why?

- **This will be in a seminar format**
  - **I'll talk for 10 or 15 minutes about each of four aspets of my analysis**
  - **Then we'll have 10 to 15 minutes of Q&A, back and forth discussion about the main points including examples and counterexamples that you'd like to contribute**
  - **The aim is for about two hours overall, with half of that coming from you.**

Is U.S. Growth Coming to an End?

- **The Great Controversy**
  - **My forecast is that U. S. economic growth is almost over**
  - **Be careful, every number compares pre-2007 with post-2007.**
    - **We are not talking about growth in 2014 vs. 2013. We're talking about the growth in potential output and how far we are below potential output**
  - **Growth of per-capita income 1891-2007 was 2.0 percent, post-2007 forecast at 0.9 percent.**
  - **Growth in disposable real income per capita of bottom 99% will fall to 0.2 percent, compared to 2.0 pre-2007**

The Role of the Headwinds vs. Innovation

- **The Primary Role of the Headwinds**
  - **These have nothing to do with innovation**
  - **They are relatively uncontroversial**
  - **They account for 1.2 percentage points of the 1.8 percentage point of growth slowdown after 2007.**
- **Slower innovation began in 1972, not now**
  - **Slower innovation after 1972 compared to pre-1972 accounts for the other 0.6 of the slowdown.**
- **Total slowdown: 1.8 points from 2.0 to 0.2**
  - **Of this, 1.2 headwinds and 0.6 innovation 40 years ago**

Who are the Opponents?
The Techno-Optimists

- They don't talk about headwinds at all, just about innovation
- They have nothing to say about my 1.2, only about my 0.6.
- The techno-optimists are led by two MIT economists, Erik Brynjolfsson and Andrew McAfee
- They preach small robots and big data exploding from trillions to quadrillions to quintillions and beyond
- I have debated them many times
- My message today. The big issues are the headwinds, which are less controversial
- We'll return to the innovation controversy at the end

Headwinds are Nation-Specific, but Innovation is a Free Good

- **Irony: what's bad for the U.S. may not be so bad for Europe**
- **Headwinds include demography, education, inequality, debt, globalization, and energy/ environment**
  - **Headwinds are nation-specific and may be less important in some European countries**
- **Innovation may originate in the U.S. than in other countries but is a worldwide "free good"**
- **Europe is at the same frontier as the U.S. in tablets, smart phones, whether these innovations occur in the U.S. or not**

End of Growth? Compared to What?

- This is *only* about the U. S.
  - Not about China or other emerging economies
  - Application to Europe is by analogy
- The criterion of "growth" is the percentage annual change of real GDP per capita
  - The high hurdle: 1891-2007 growth of 2.0 %
- The criterion of doubling
  - Growth at 2.0 percent doubles every 35 years
  - Growth at 0.2 percent doubles every 350 years
- Americans got used to their standard of living doubling from that of their parents. No more.

We Care About the Standard of Living, Not the Same as Productivity Growth

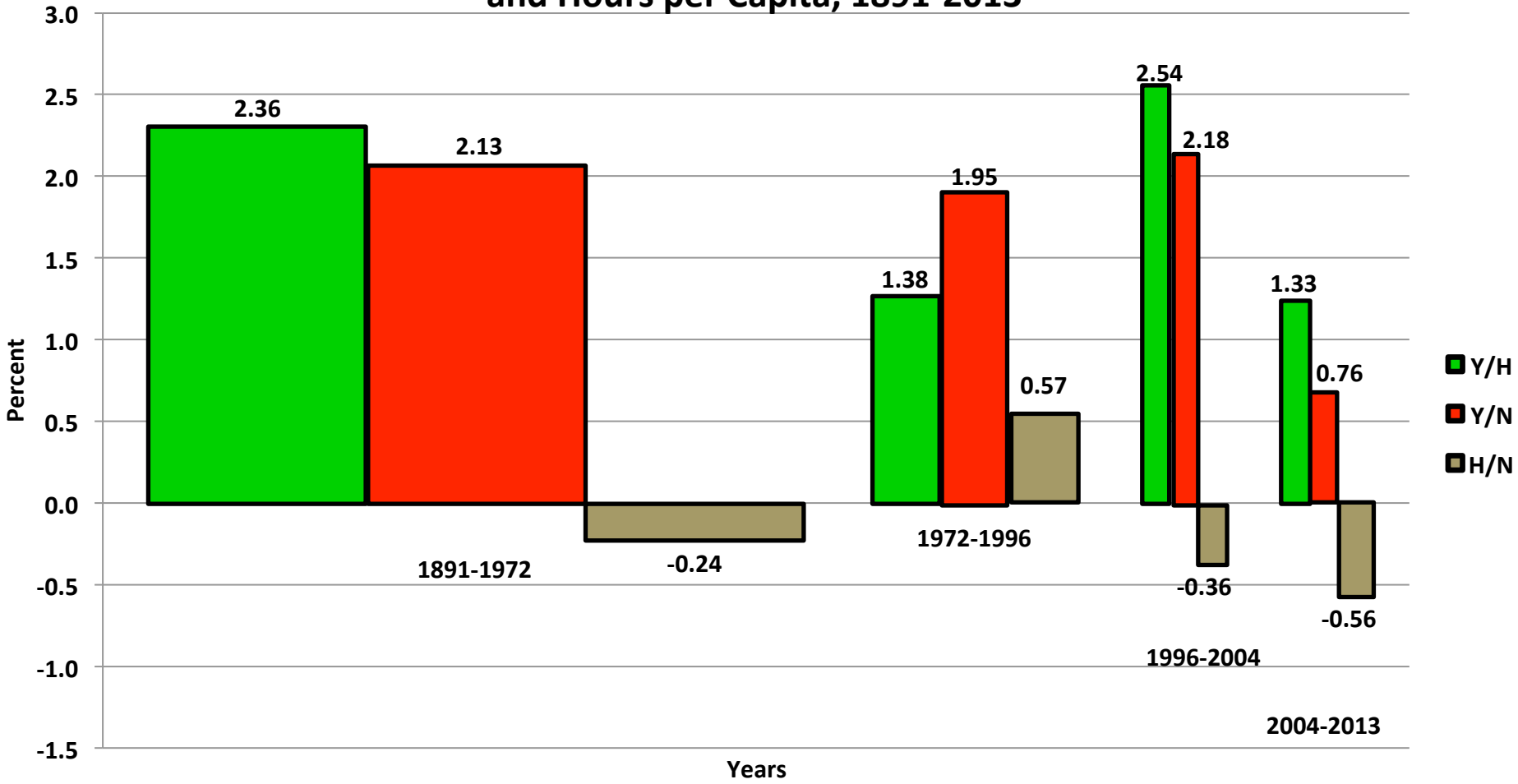
- Total Output or GDP (Y).
- Total Hours of Work (H).
- Total Population (N).

- The Magic Equation

$$Y/N \equiv Y/H * H/N$$

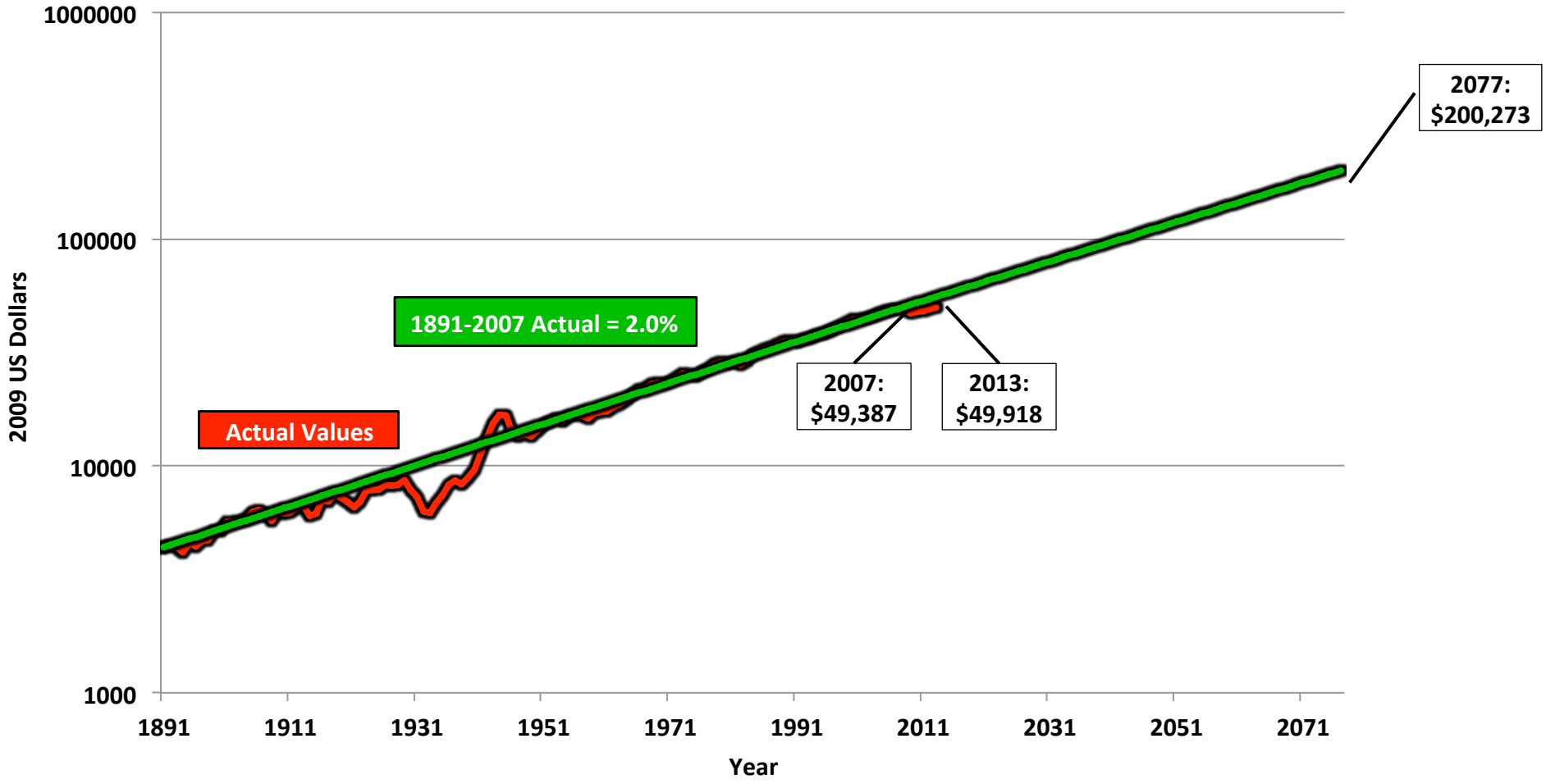
The Magic Equation in Action, 1891-2013

Figure 2. Annualized Growth Rates of Output per Hour, Output per Capita, and Hours per Capita, 1891-2013



2.0 Percent Growth in the Past, Will It Continue Into the Future?

Figure 1. Prospective Level of 2077 Real GDP per Capita



Optimists Sometimes Show This Chart. Growth Continues at 2.0 Percent

- **The optimists don't know about the magic equation**
- **They don't know that:**
  - **Output per capita growth fell by half after 2004**
  - **Productivity growth slowed 1972-96 yet output per capita continued to grow at 2.0% *BECAUSE OF THE ENTRY OF FEMALES INTO THE LABOR FORCE***
  - **That temporary boost to Y/N relative to Y/H growth ended in the 1990s. Instead of rising as in 1972-96, hours per person have been declining since 1996.**

The U.S. Faces Four Major Headwinds

- ***The headwinds are separate from the debate over innovation. They are less controversial.***
- **Demographics** ***(Reduction in H/N)***
- **Education** ***(Reduction in Y/N and Y/H)***
- **Inequality** ***(Y/N for Bottom 99% falls short of average Y/N)***
- **Debt** ***(Disposable income grows slower than output)***

Components of the Demographic Headwind

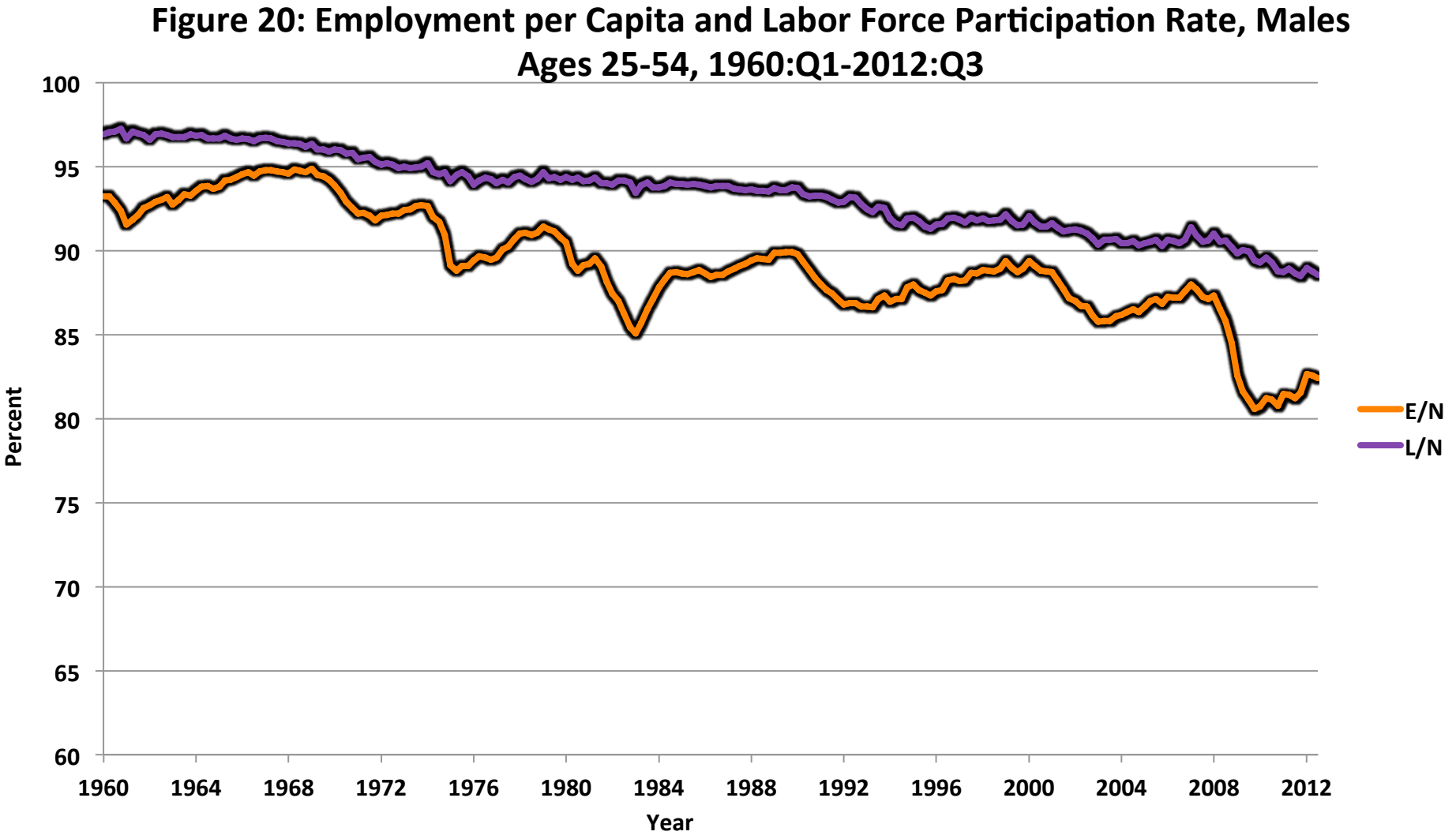
- **Baby Boomers**
  - Their hours go to zero when they retire but they are still part of the population

Effect lasts from 2009 to 2034

The Decline in Hours per Capita is Not Just About Baby-boom Retirement

- **Prime-Age Males**
  - **Employment/Population Ratio 95% in 1968 to 83% in 2012**
- **Youth**
  - **Employment/Population Ratio 65% in 1988 to 46% in 2012. Only about 1/3 of this decline is accounted for by increased school participation**
- **Females 20 and Over**
  - **Labor Force Participation Rate rose 35% in 1968 to 58% in 2000, then fell back to 55% in 2012**

Prime-Age Male Participation Is Part of the Demographic Headwind



Components of the Education Headwind

- **Rising educational attainment has contributed to long-term economic growth. For 25-29 age group**
  - **High school graduates: 7% 1900, 38% 1940, 81% 1970, now 84%**
- **4-year College**
  - **2% 1900, 23% 1970, 32% now**

Problems Throughout All Levels of American Education

- PISA International Rankings of secondary schools, released December 2013:
- US is #21 in reading, #31 in math, #23 in science PISA International Rankings of secondary schools
- College: About 1/3 of recent college graduates are in jobs which do not require a college education
- College tuition cost inflation since 1972
  - Adjusted for overall inflation, HE price up 3.7 times
  - Annual tuition/fees $50,000 Harvard, $6,000 Univ of Toronto
  - Indebted baristas and taxi drivers
- $1 Trillion in college debt
  - Delaying marriage, delaying children, distorting job choices

First Break: Summary of Issues to Discuss

- Is the distinction between the headwinds and innovation clear?
- Is the distinction between post-2007 and post-2014 growth clear?
- Is the Y/N = Y/H * H/N dichotomy new? Any questions
- What do you find surprising about the history since 1891 of Y/N, Y/H, and H/N?
- Demography Issues – Why Are So Many People Dropping Out of Labor Force?
- Education Issues – vs. other countries, what to do?

The Magic Equation in Action, 1891-2013

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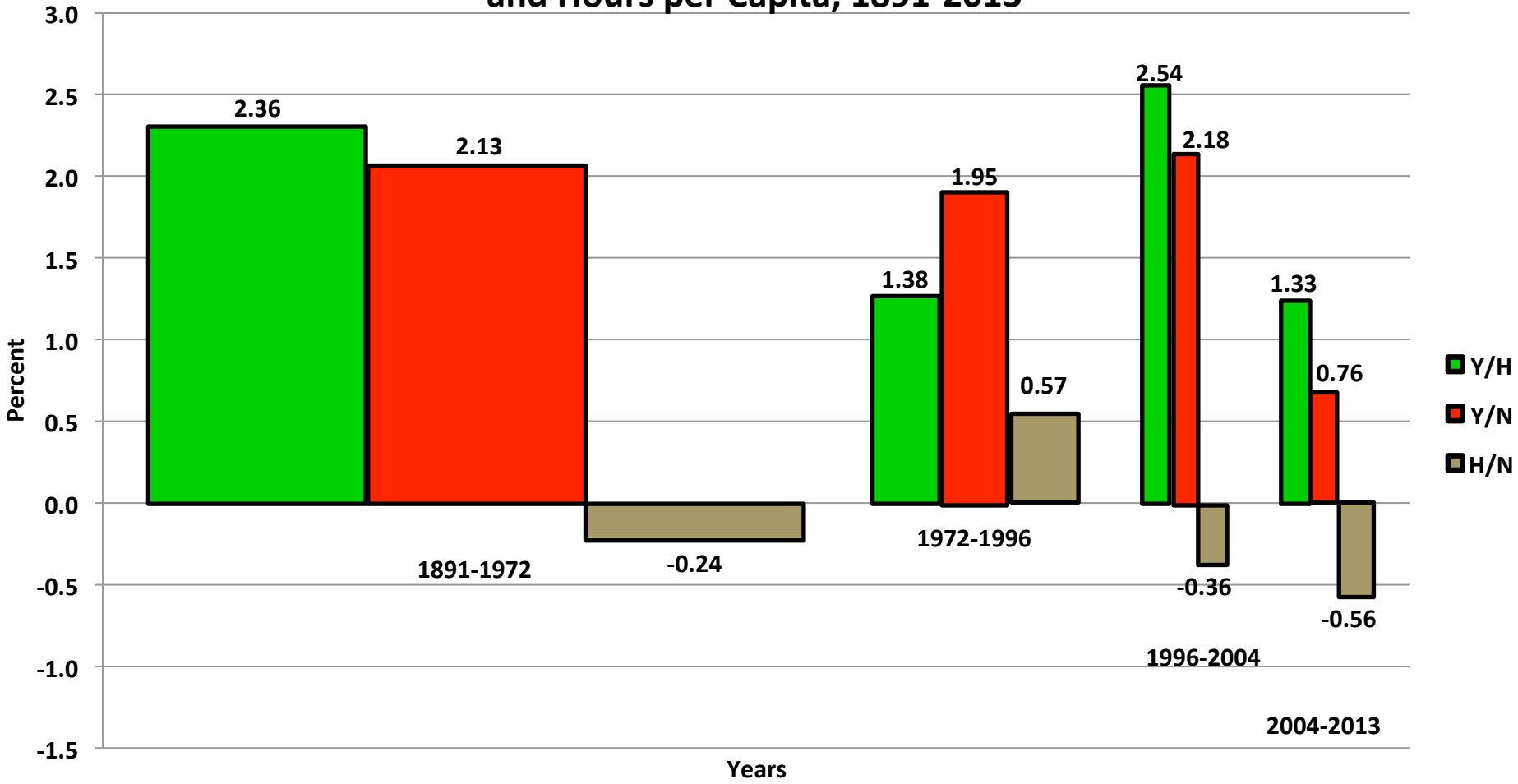
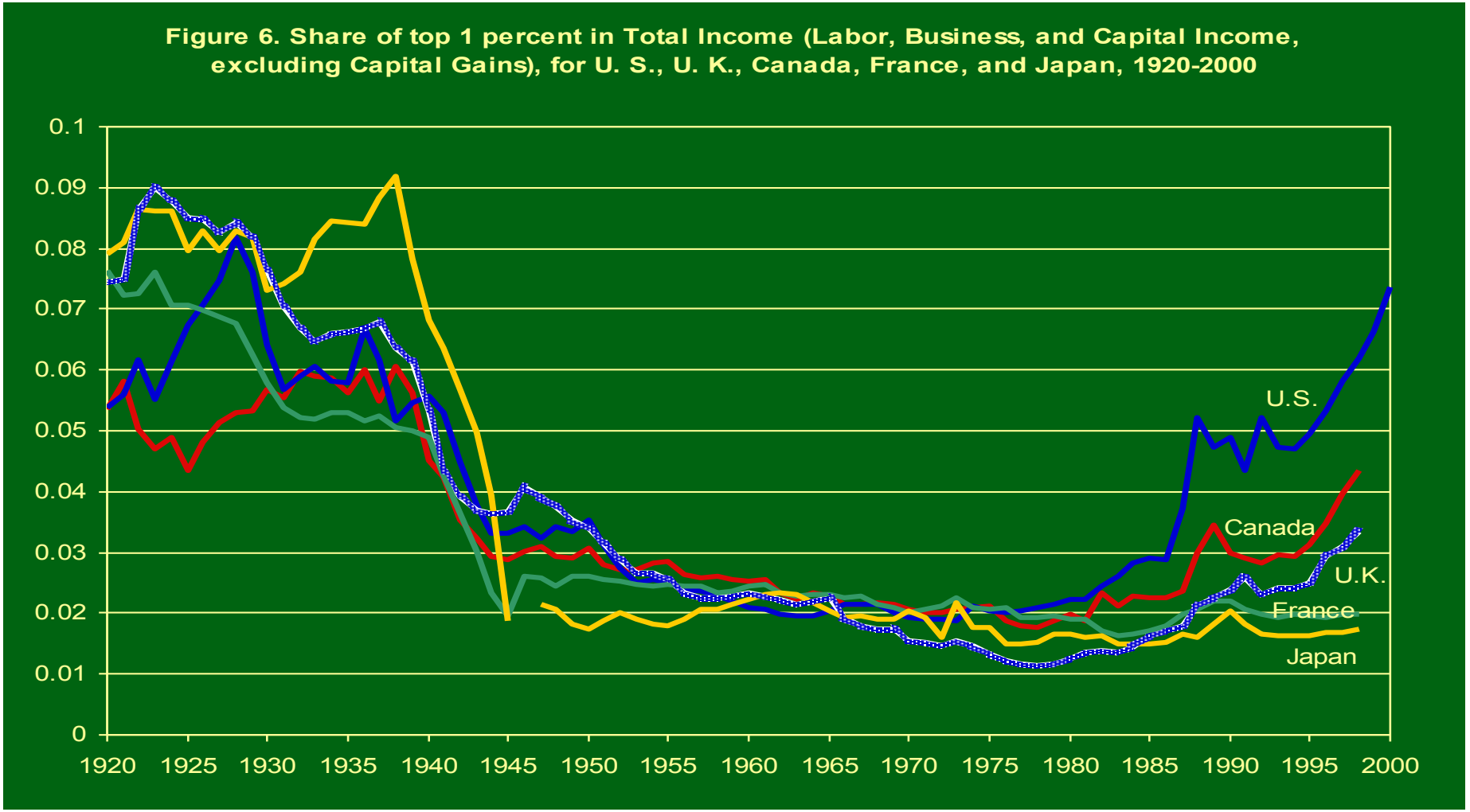


The Biggest Headwind of All: Growing Inequality

- U-Shaped Share of Top 1%. High 1913-29, low 1950-75, rising 1975-2013 back to original levels
- 1993-2012
  - Average Real Income Growth for Bottom 99% was 0.53% slower per year than average
  - Top 1% of distribution received 68% of all income gains

International Comparison of Inequality: the top 0.1%



Causes of Growth of Inequality in the Top 1%

- **Economics of Super-Stars**
  - Sports, entertainment
  - Explosion of worldwide media, internet, cable TV
  - Money spills from TV broadcast of sports events to the teams and then to the athletes themselves
- **Unregulated explosion of the finance industry since 1990**
  - Real output or rents?
- **Outsized CEO compensation related to greater importance of stock options**

Causes of Growth of Inequality Below the Top 1%

- **Why wage stagnation in the Bottom 99%?**
  - Decline in the Real Minimum Wage
  - Decline of labor unions in private sector
  - Globalization: imports, outsourcing
- **Additional factors**
  - American medical care system, no benefits paid to part-time workers
  - America is alone in its medical care system, a headwind Europeans do not experience
- **Lack of German-type apprenticeship system**
  - College grads driving taxis while shortage of skilled factory workers

The Termites in the Bottom 1/3 of the White Population

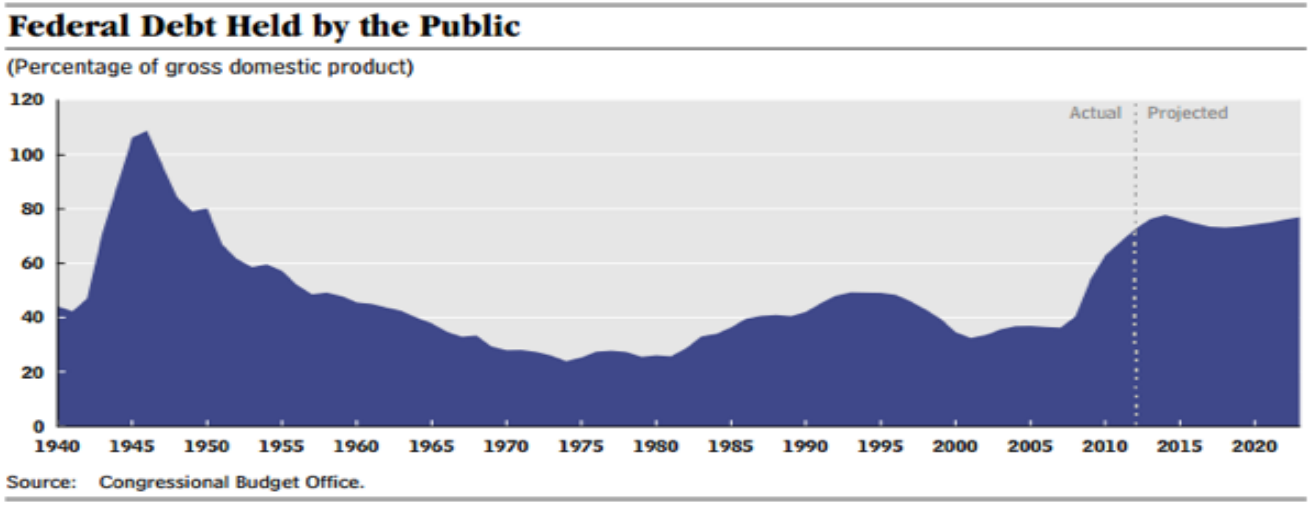
- **The New Causes of Declining Incomes at the bottom 1/3 of the white population**
  - **with the meticulous statistical documentation of Charles Murray's Coming Apart (Belmont vs. Fishtown).**
- **All data compare Fishtown 1960 to 2010. Sociological facts**
  - **Fishtown aged 30-49 married, 85% in 1960 to 48% in 2010**
  - **Fishtown never married aged 30-49, 8% in 1960 to 25% in 2010**
  - **Divorce rate aged 30-49, 5% in 1960, 33% in 2010**

More on the Termites in Fishtown

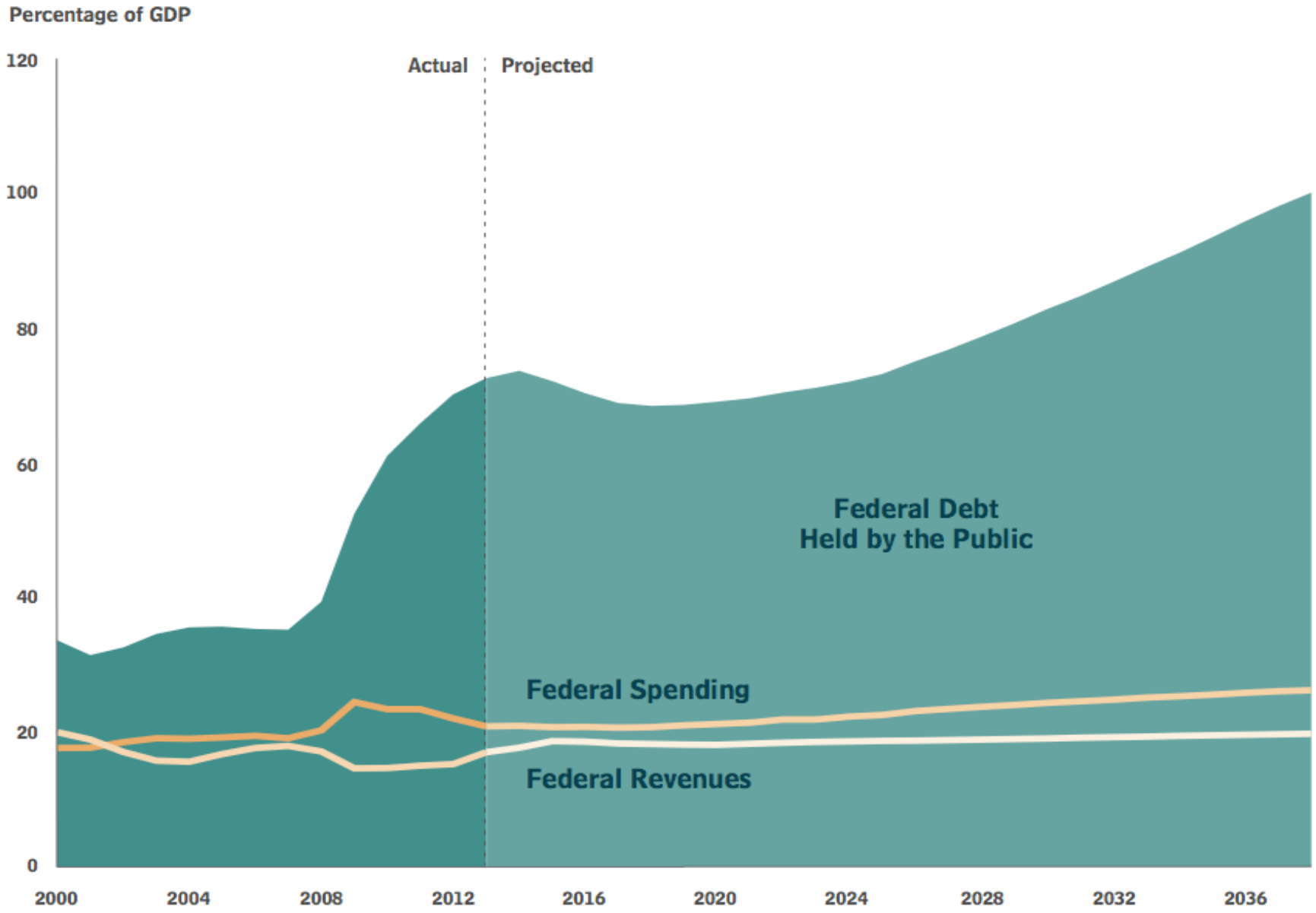
- **This is a sociological decline, not just an economic decline. But the two interact**
  - **Most stunning: % of children living with both biological parents when mother is age 40, 95% in 1960 to 34% in 2010**
  - **Dire consequences for the future educational attainment of these children, especially boys**
  - **Shortage of eligible men for more highly educated women**
- **Decline in hours per person**
  - **Families in which the head of household or spouse worked 40 or more hours in the preceding week: 84% in 1960, 58% in 2010**

Stabilize Ratio of Government Debt to GDP

- **Federal, State, and Local Debt**
  - **Deficits don't have to go to zero, but the ratio of debt to GDP must be stabilized**
  - **Medicare runs out of money in 2026, Soc Security in 2033**
  - **Stabilizing debt/GDP means faster growth in taxes and/or slower growth in spending on entitlement programs**



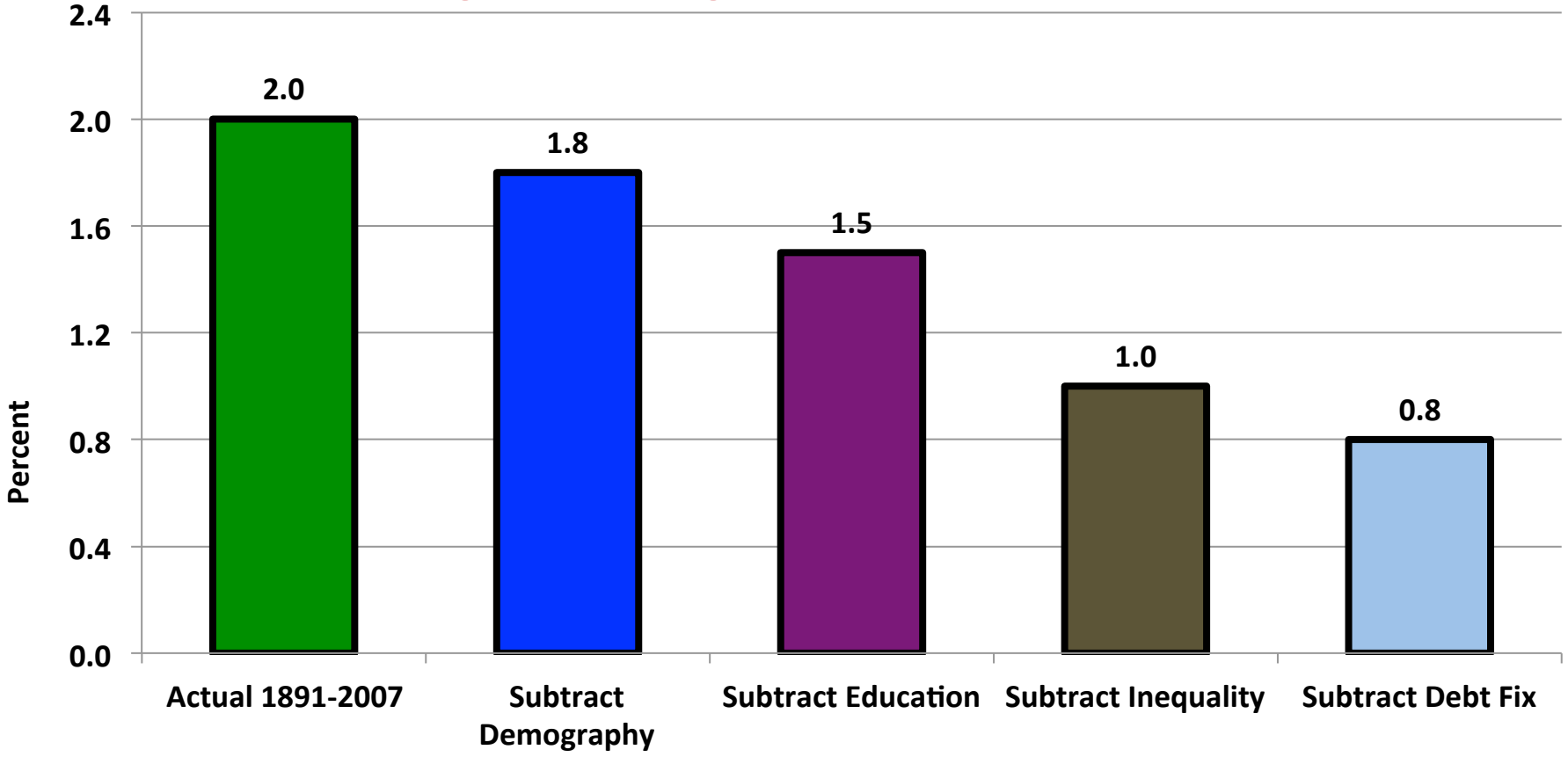
Federal Debt/GDP Ratio, 2000 to 2038



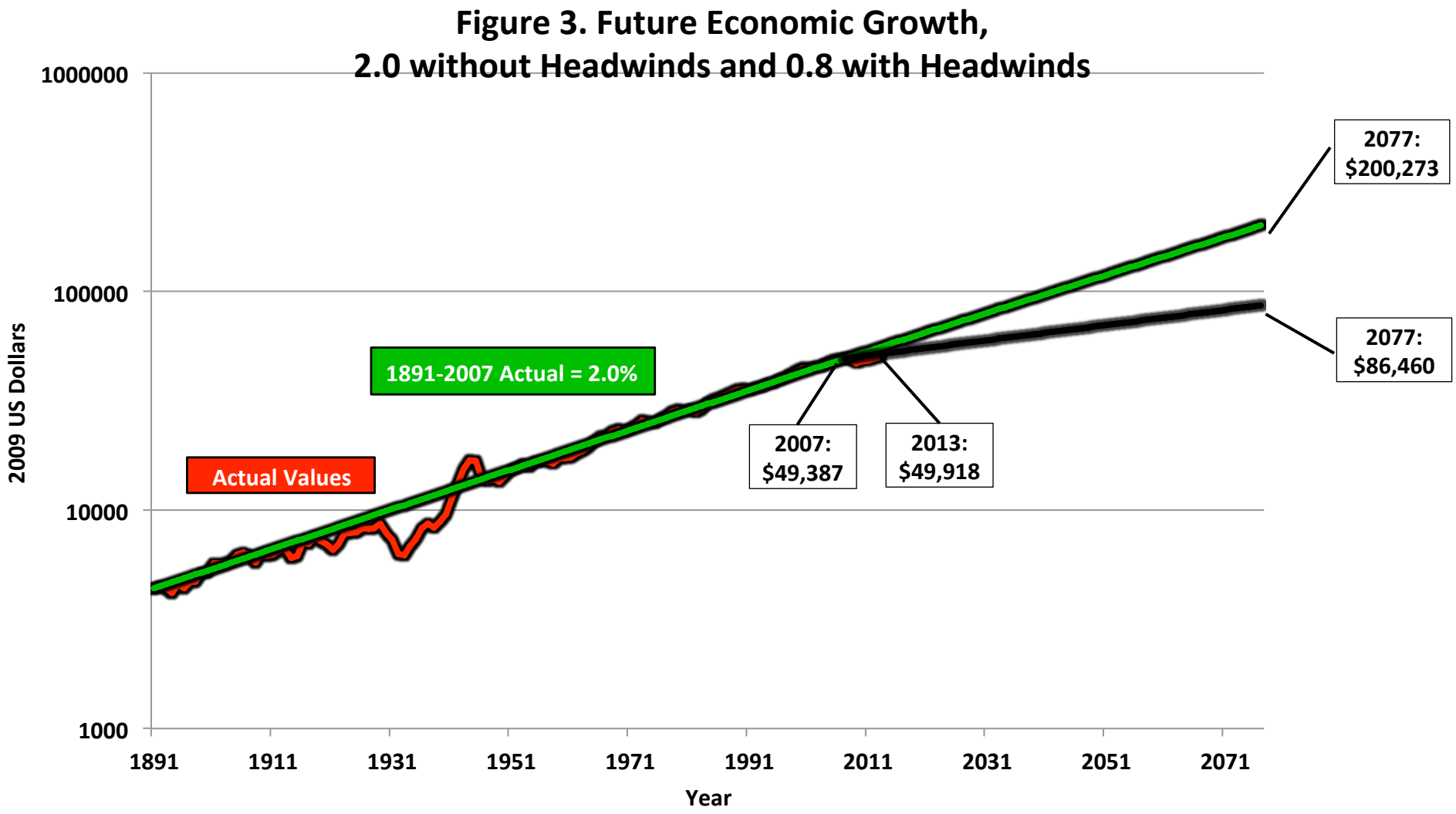
How to Stabilize Debt-GDP Ratio?

- **If real benefits rise at the same rate as in the past, Social Security will run out of money because of the higher dependency ratio (old people / young people)**
- **This can be fixed only by some combination of slower growth of benefits and faster growth in taxes**
  - **Either way, slower growth in disposable income**
  - **I estimate it as roughly 0.2% less growth per year.**

Without a Word about Innovation, Implications for the Disposable Real Income per Capita of Bottom 99%

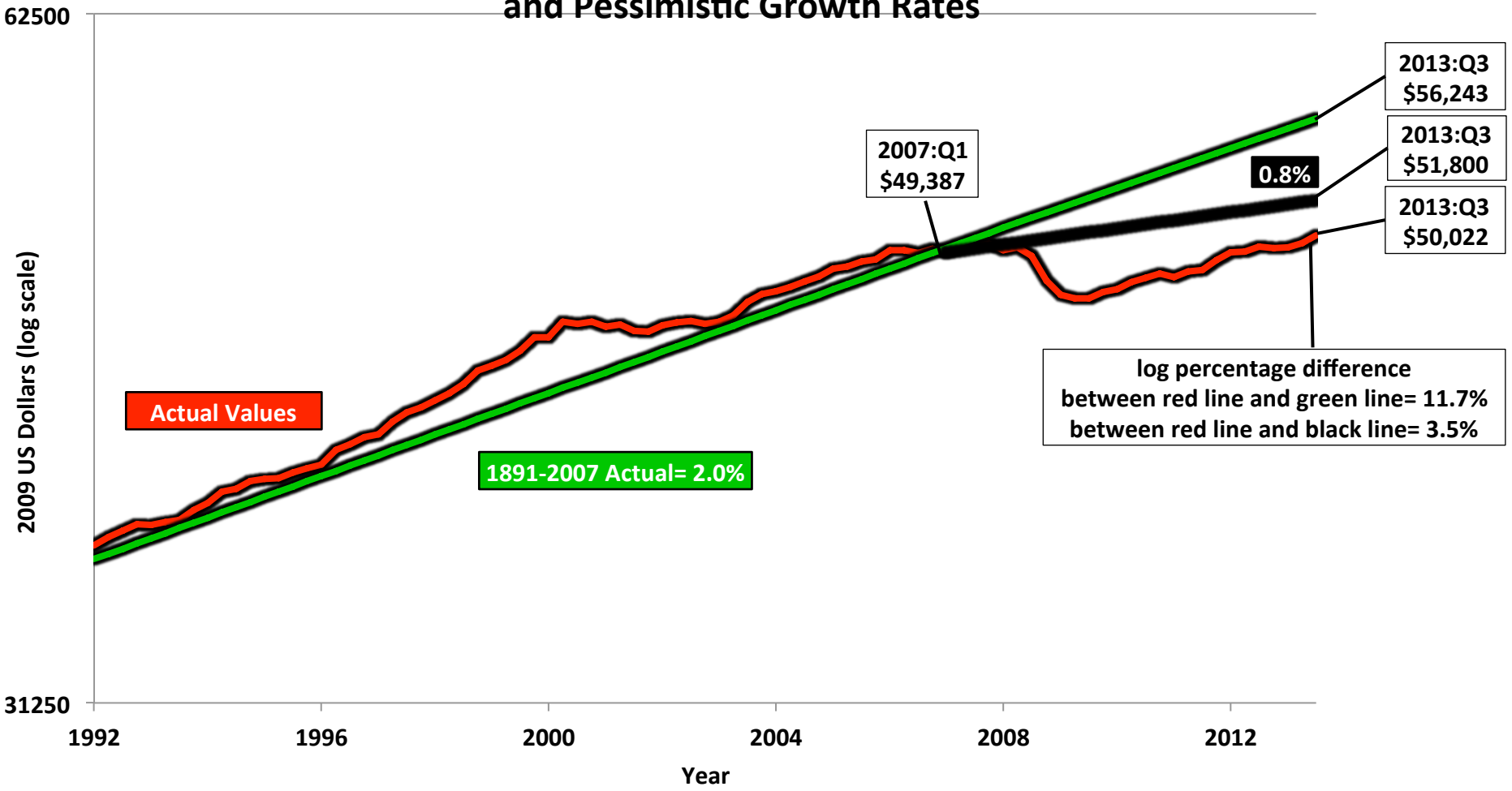


Subtracting the Headwinds from Future Growth



How Are We Doing Now?
Below Pessimistic Trend

Figure 4. Level of Real GDP per Capita through 2013:Q3, Actual, Optimistic, and Pessimistic Growth Rates



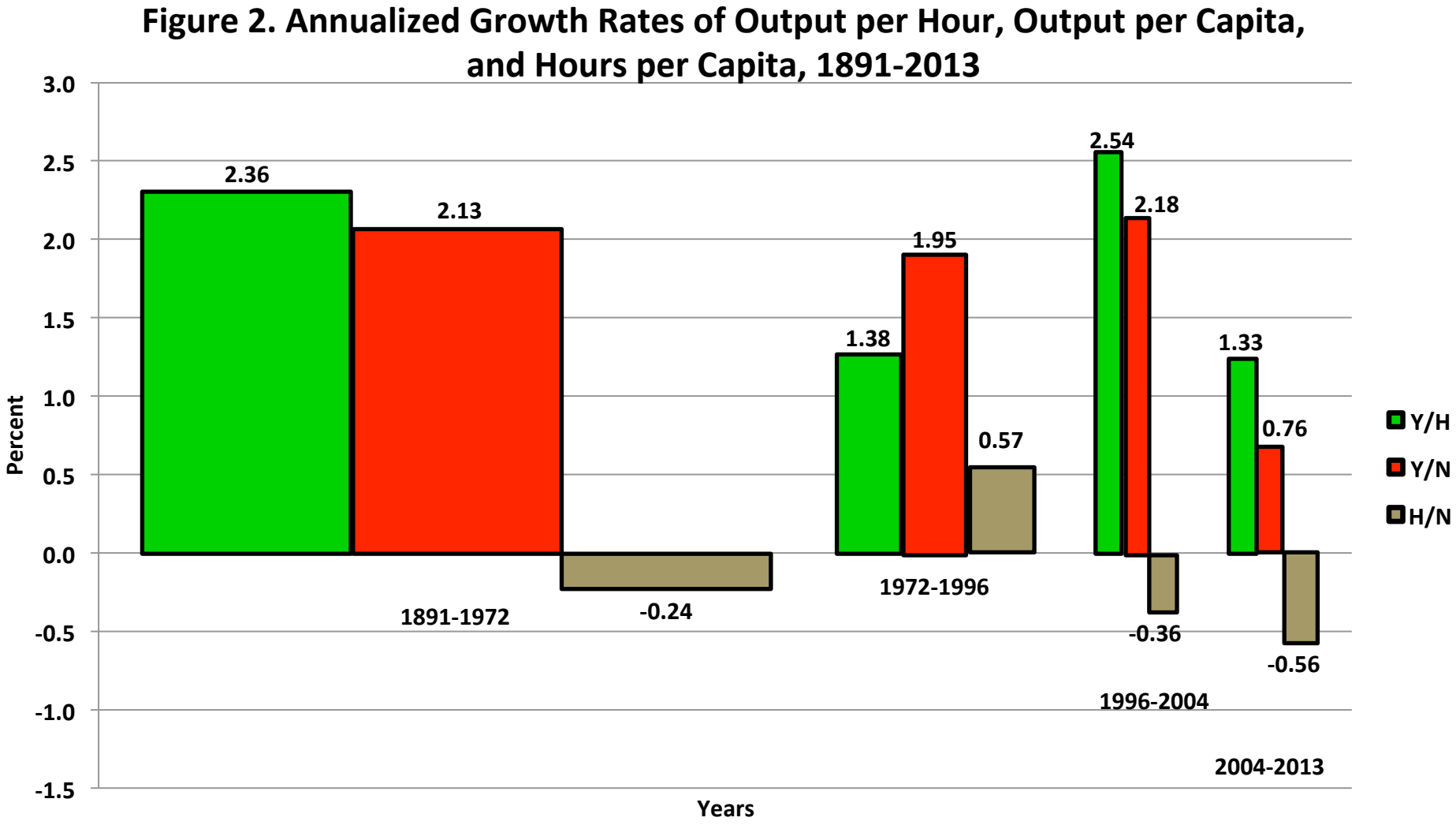
Time for the Second Break

- **How do you explain growing income inequality at the top?**
  - **Is it inevitable?**
  - **Should anyone do anything about it?**
- **How do you explain growing income inequality at the bottom?**
  - **Do you see skill shortages?**
  - **What can be done about dropping out?**
- **Does the debt/GDP ratio problem need to be fixed? How?**
- **Comparison with where we should be with where we are. Comments, future?**

Move from Headwinds to Innovation

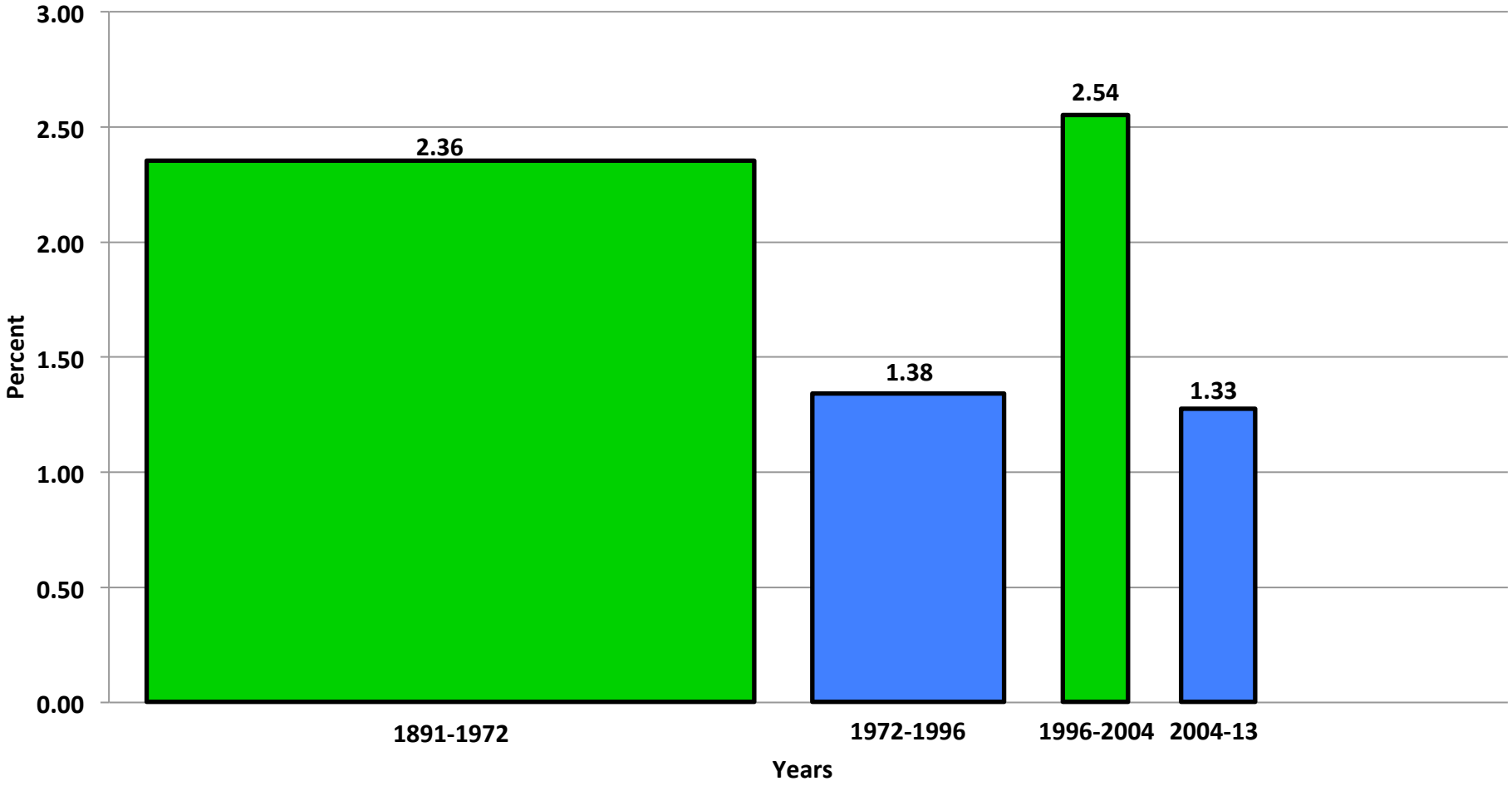
- **Until now, we've subtracted the headwinds from the actual growth performance of 1891-2007, which assumes that the role of innovation in growth in the future will be the same as 1891-2007.**
- **Now we reverse the exercise in subtraction. *Now we pretend that there are no headwinds and look just at innovation.***
- **First, let's look at history.**

The Four Eras of Productivity Growth



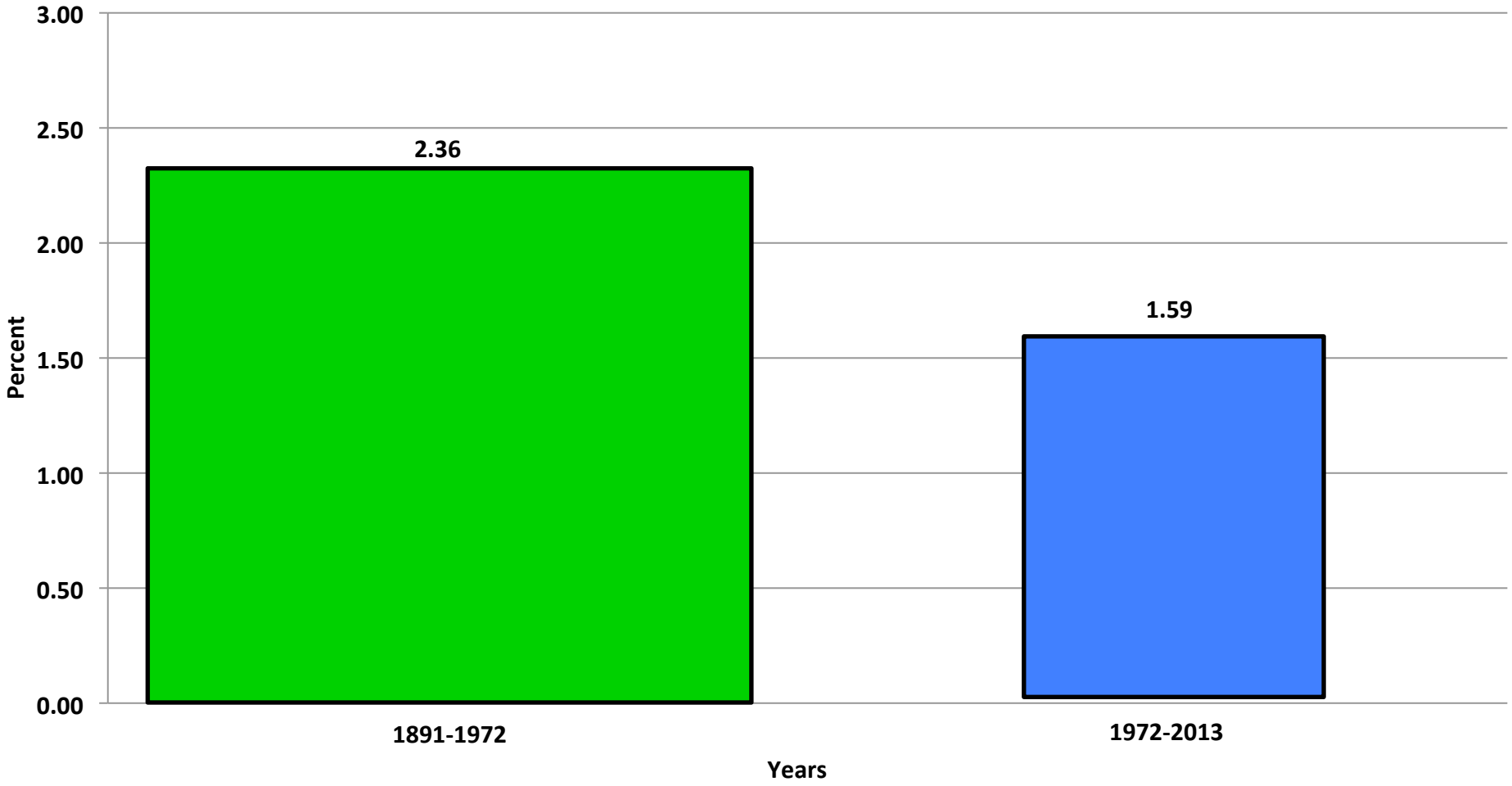
The Same History, Just for Productivity *(Y/H)* Growth

Figure 5. Annualized Growth Rates of Output per Hour, 1891-2013



The Second Industrial Revolution vs. the Third Industrial Revolution

Figure 6. Annualized Growth Rates of Output per Hour , 1891-2013



The Three Industrial Revolution: Definitions

- ***The 1st IR occurred 1770-1850, continued impact through 1900***
  - **Steam engine, cotton spinning and weaving**
  - **Railroad, steam-powered ships, shift from wood to iron and steel**
- ***The 2nd IR occurred 1870-1920, continued impact through 1970 (at least 5 dimensions)***
- ***The 3rd IR 1960-now, one dimension, the ICT revolution***

What Happened to Make Productivity Growth So Rapid 1891-1972?

- ***The 2nd IR (1875-1900) consisted of at least five dimensions of Great Inventions***
  - **Each invention had spinoffs developed over 1890-1972**
  - **Those fundamental inventions of 2nd IR kept productivity growing at 2.33% 1891-1972**
  - **Many benefits of 2nd IR have produced benefits that have never been measured**

The 3nd IR includes everything that computers and digitalization have created since 1960.

So far it has produced about 1/3 as much cumulative productivity gain as the 2nd IR

Light and Power

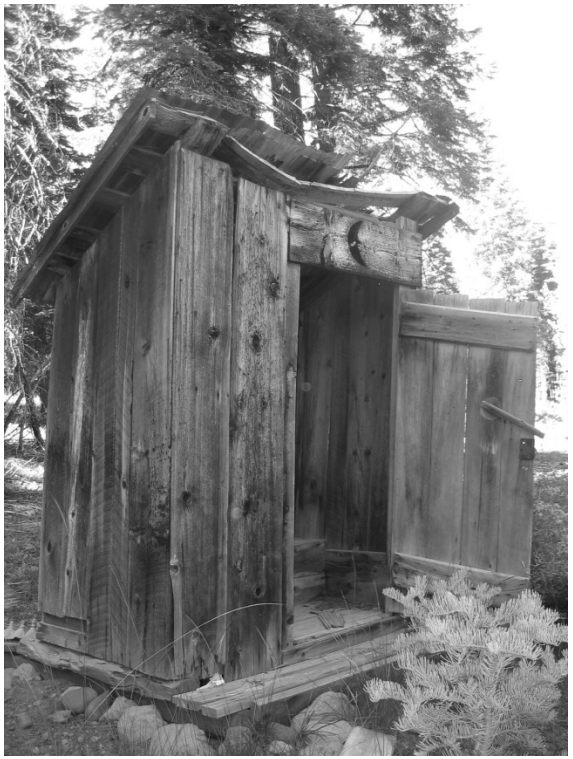
- Before 1879 reading at night required lamps fueled by kerosene or gas.
  - Odors, pollution, dim light, and hard to control
- By 1929 in urban America
  - Electric light everywhere indoors and out
  - Elevators created skyscrapers and urban density
  - Electric hand tools and machine tools replaced hand work
  - Electric streetcars, the Chicago El, the NYC Subway

Internal Combustion Engine

- Before 1900 horses carried cargo and people
- The average horse produced 20 to 50 pounds of manure and a gallon of urine daily
- The daily amount of manure worked out to between 5 and 10 tons per square mile
- Carcasses of dead horses often lay in the streets for days, creating a public health menace
- American roads were described in 1903 as “simply two deep ruts, with a stony ridge in the middle on which the car bottom will drag”

The Most Important Event in Women's Liberation? Running Water

- In 1885 the average NC housewife walked 148 miles per year carrying 35 tons of water
- Clean water was carried in for cooking, laundry, washing dishes, and commodes.



- And the same amount of dirty water had to be carried out.
- The American home became connected to water pipes and sewers between 1870 and 1929
- Outhouses were replaced by indoor bathrooms with toilets, bathtubs, and showers at the same time

Completing Female Liberation

- No more need to carry water in and water out
- The slavery of laundry was eliminated by the electric washing machine (1920-1950)
- The slavery of daily shopping was eliminated by the electric refrigerator (1920-1950)
- The slavery of hauling in coal or wood to the kitchen hearth was eliminated by central heat (coal, oil, or gas) in the same time period
- By 1929 almost all urban homes were totally "networked"

The Kitchen in 1870: Where is the Sink, the Refrigerator, the Range?

A Well-Equipped Kitchen of the 1920s

A Well Equipped Kitchen of the 1950s

100%

Something Cannot Be More Than 100% of Itself

- Electrification from 0 to 100% (1880-1930)
- Motor vehicle ownership 0 to 80% (1900-1929)
- Travel as a % of speed of sound, 1% to 80% (1830-1958)
- Running water, sewers, indoor bathrooms 0 to 100% (1870-1929)
- Urbanization 25% to 75% (1870-1929)
- Postwar: Female Labor Force Participation 20% to 60%

Why Did Productivity Grow Faster In the Century Before 1972? The One-Time-Only Inventions

- Polluting flames for light >> instant on-off electric light
- Crude hand tools >> electric hand tools
- Factories steam engines and belts >> electrified
- Offices and home cold and hot >> air-conditioning
- Low density walk-ups >> elevators in hi-rise buildings
- Horses >> motor vehicles
- Railroads >> interstate highways and air travel
- Mainly rural 1870 >> mainly urban 1950

More One-Time Changes Before 1972

- Carrying pails of water >> running water
- Outhouses >> indoor bathrooms
- Sewage in streets >> sanitary sewer pipes
- Infant mortality 20% >> infant mortality 1%
- Letter-writing >> telephone talking
- Player pianos >> phonograph listening
- Isolation >> world contact via radio >> TV
- Motion Pictures: Nickelodeon >> “Gone With the Wind”

More One-Time Changes Before 1972

- Death from infections >> antibiotics
- FDR's paralysis >> Salk's conquest of polio
- A mouthful of cavities >> flouridated water
- A boring diet of ham & hominy >> much greater food variety by 1930
- Two or three children per bedroom >> one each
- 60 hour weeks >> 40 or less
- Hot & dirty work conditions >> air conditioned office jobs

0%

Other Great Inventions: Something Can't Be Reduced Below Zero Percent

- **The Greatest Improvement of All? Infant mortality decreased from 22% to 1% between 1890 and 1950.**
- **Central heating and air conditioning reduced the variance of indoor temperature**
- **Auto fatalities per vehicle-mile have declined by a factor of 10 since 1950**

How Important Were Innovations During 2004 – 2014?

- A thought experiment
- Choice A: You get 2004 electronic technology and get to keep running water and indoor toilets. But you cant use any electronic invention introduced since 2004. (You can keep Wikipedia & Amazon & Google & ipod)
- Choice B: You get everything invented in the past decade, right up to Facebook, Twitter, and the iPad, but you have to give up running water and indoor toilets. You have to take your iPad to the outhouse. If you want a bath, put down your ipad and go out and carry water inside in a pail. And 22% of your newborns will die, since you face 1890 levels of infant mortality.
- Which do you choose?

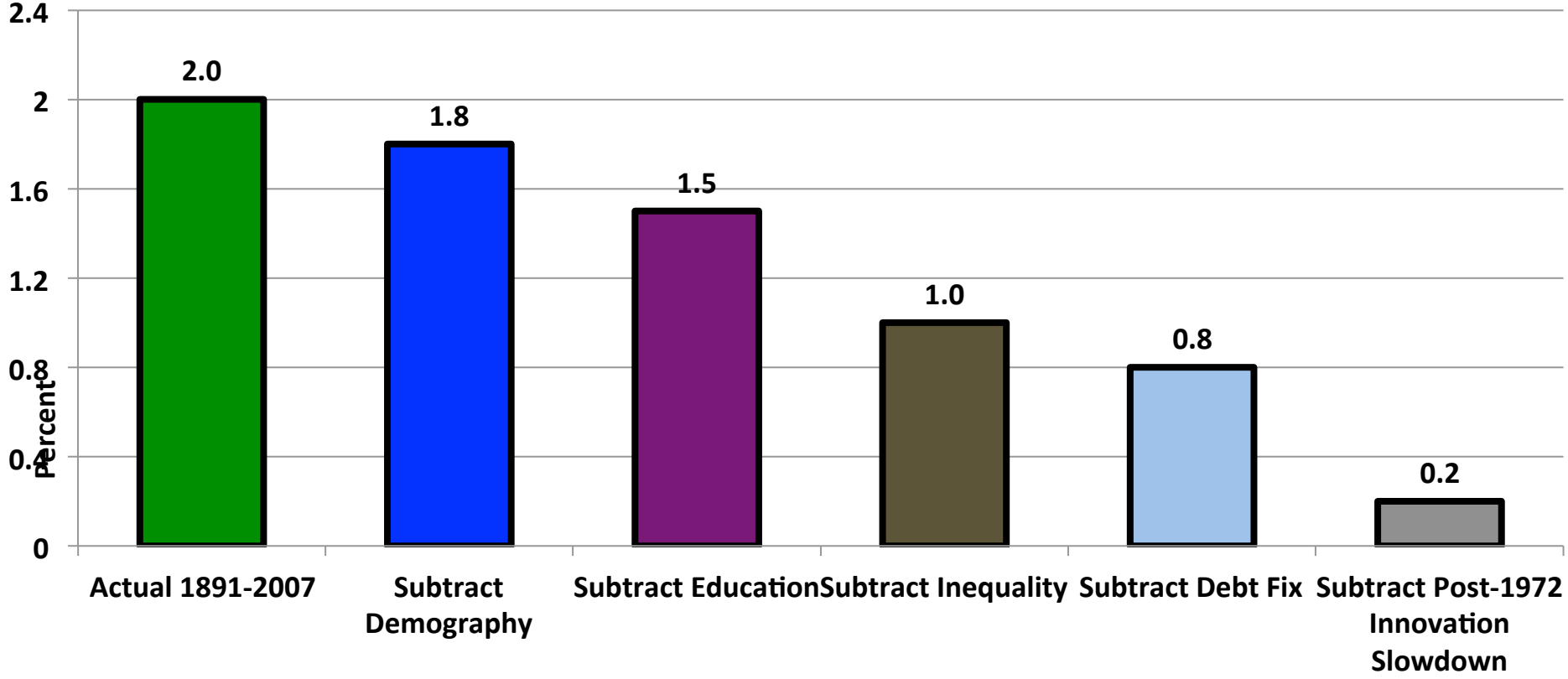
Tribute to the Toilet

- But it wasn't just the toilet
- Carrying water in for cooking, laundry, and hygiene
- Carrying all that water back out

Storm Sandy: Historical Rewind

- **For those most impacted by Sandy, including several elite professors in Princeton, NJ, they temporarily lost the 20th century**
  - **No electricity**
  - **No running water**
  - **No cooking, no hot water, no hot showers**
  - **No heat because electric thermostats didn't work**
  - **No gasoline available because the pumps didn't work**
  - **Modern gadgets including iPhones could not be recharged**

Summary of Subtraction from 2.0 to 0.2, Disposable Real Income per Capita of Bottom 99%



Implications for Future Growth

- **0.2 percent growth in disposable income of the bottom 99% implies**
- **0.9 percent growth in economywide real GDP per capita (compared to historic 2.0)**
- **1.3 percent growth in economywide real GDP per hour (compared to historic 2.2)**
- **Conclusion: growth is not "over" for the entire economy, but it will virtually disappear for the bottom 99%.**

Summary of Second Industrial Revolution

- Long diffusion period of electricity. Light 1879, power station 1882, but the real impact on manufacturing came in the 1920s.
- Motor vehicles. Engine 1879, but first vehicles 1900. Two decades needed to invent power train, transmission, brakes. Fast diffusion after 1900.
- Multiple dimensions: electricity, motor vehicles, water/sewers, food regulation, decline in infant mortality, communication, entertainment, chemicals.
- 100 years required to realize full benefits: TV, air conditioning, air transport, interstate highways

Break #3: Thinking about Historical Innovation

- General discussion of the inventions of the second industrial revolution. Which were the most important? Which have I left out? When did the IR #2 innovations peter out, and why?
- Ask the same questions about IR #3. Which were the most important?
- How is work in your office different than 10, 20, 30 years ago? Were clerical employees replaced by machines mainly 1970-2000? How much has changed since 2000?
- What are the most important differences in your house compared to your parents? (try to hold real income constant)
- What are the biggest differences in the ways you spend leisure time compared to your parents?

Last Part: Framing the Debate About Future Innovation

- **The myth that the future cannot be forecast.**
  - **"Any pessimist gazing into the future is condemned y a lack of imagination and doomed to repeat the mistakes of past pessimists."**
  - **Examples: Jules Verne 1863, on the verge 1875, Ladies Home Journal 1900, New York World's Fair 1939, Norbert Wiener 1949.**
- **Many innovations will occur over the next 40 years, but will they be as important as the last 40? They must be as important, or else my growth forecast is too optimistic**

The Next 40 Like the Last 40? What a Stunningly Optimistic Outlook!

- **Think what it means to assume that innovation in the next 40 years will match the last 40.**
- **The next 40 years must bring us innovations as important as**
  - **The PC, the internet, e-commerce**
  - **Mobile phones, smart phones & pads**
  - **Digitalization of library catalogues and parts catalogues**
  - **Revolution in office equipment and procedures**
  - **Bar-code scanning, the ATM machine, i-tunes, cable TV, CDs, DVDs, movie streaming**

Comments on Techno-optimists, Brynjolfsson and McAfee

- Their optimism centers on an explosion of data – billions >> trillions >> quadrillions
- Anything that grows exponentially explodes, implying a limitless future
- They forget
  - U. S. growth has always been exponential
  - 2.0 percent growth means 100 grows to 738 after 100 years
  - 0.9 percent growth means 100 grows to 246 after 100 years
- Growth is inherently an exponential process, but no trillions or quadrillions in sight for per-capita output

Comments on the Techno-optimists

- **Most big data is used in marketing, that is, stealing market share from competitors. Zero-sum game**
- **The *Economist* reported that ICT expenditure was growing 3X faster in marketing departments than any other part of large business firms.**
- **Stubborn resistence of the productivity data over the past decade since 2003 to recognize the explosion of big data as relevant to real jobs in our largely service economy, dominated by health, education, bars, restaurants, and retail.**
- **My "walk around" test of robots' future impact**

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- Growth is inherently an exponential process, but no trillions or quadrillions in sight for per-capita output
- Their list: big data => artificial intelligence; small robots; 3-D printing; medical/pharmaceutial advances; driverless cars

More Comments on the Techno-optimists

- Most big data is used in marketing, that is, stealing market share from competitors. Zero-sum game
- The *Economist* reported that ICT expenditure was growing 3X faster in marketing departments than any other part of large business firms.
- Small robots. Not independent, not versatile. WSJ review of robot vacuum cleaners. Don't work with attachments.
- Lack of versatility, example UPS drivers
- They can walk but not talk, or they can talk but not walk.

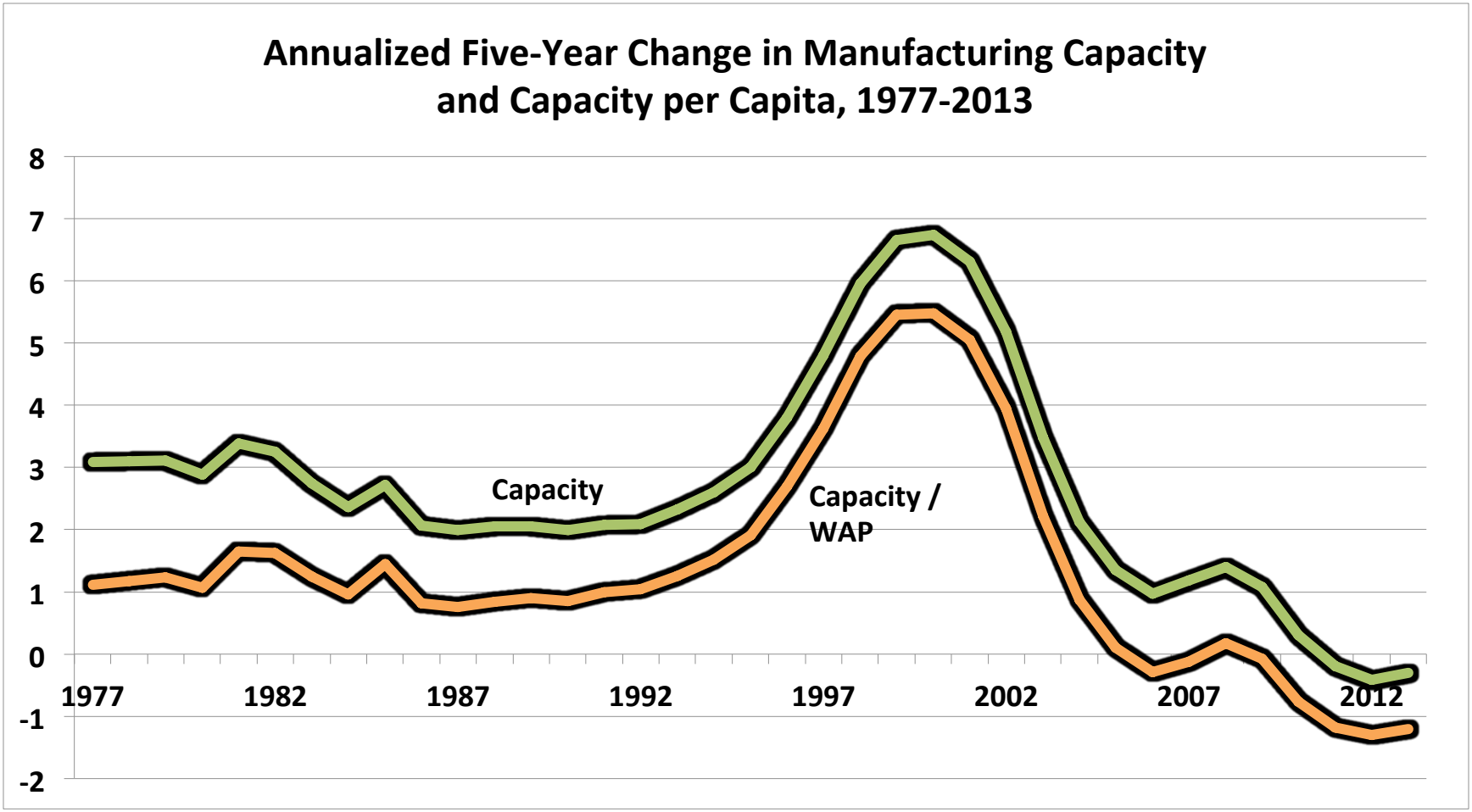
More Comments on the Techno-optimists

- 3-D printing. Perfect for doing custom models, greatly speeding up and enhancing the process of R&D of new devicies.
- Medical/pharmaceutical advances. Big data may lead to revolutionary progress in diagnosing various type of cancer (example).
- Medical research: collision with Alzheimer's
- Driverless cars. Can this compare to the invention of the car itself? What about that UPS driver?
- Barcelona mobile phone international conference – people were bored because nothing new is happening

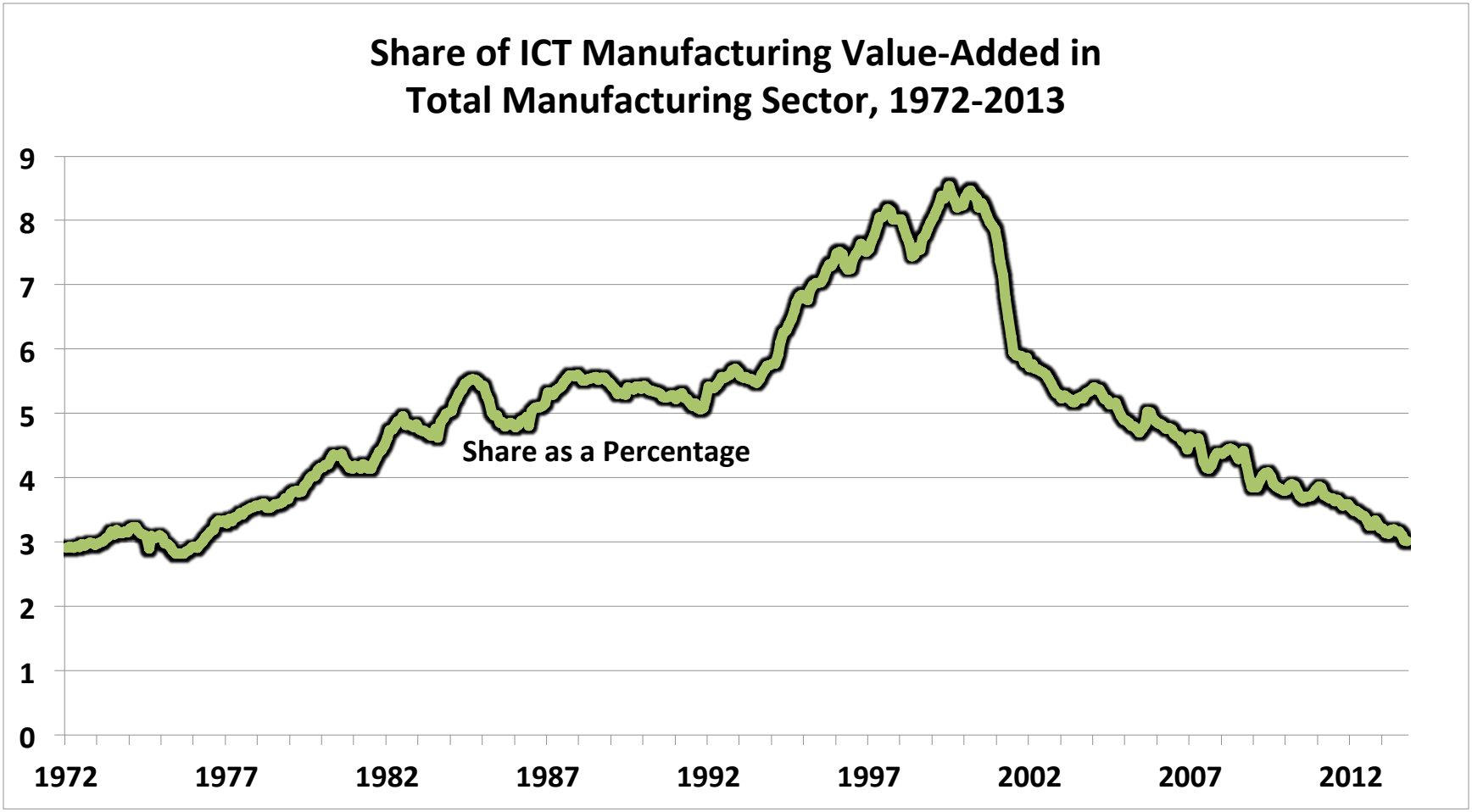
The Techno-Optimists Favorite Future Inventions

- **Has the Great Recession and Slow Recovery Dented America's Capacity to Produce?**
- **The British consul's remark, my question, and his response**
- **Superficially, manufacturing looks OK, with steady and rapid productivity growth**
- **Three pieces of evidence that the productivity revival of 1996-2000 was a special case and is not being repeated.**

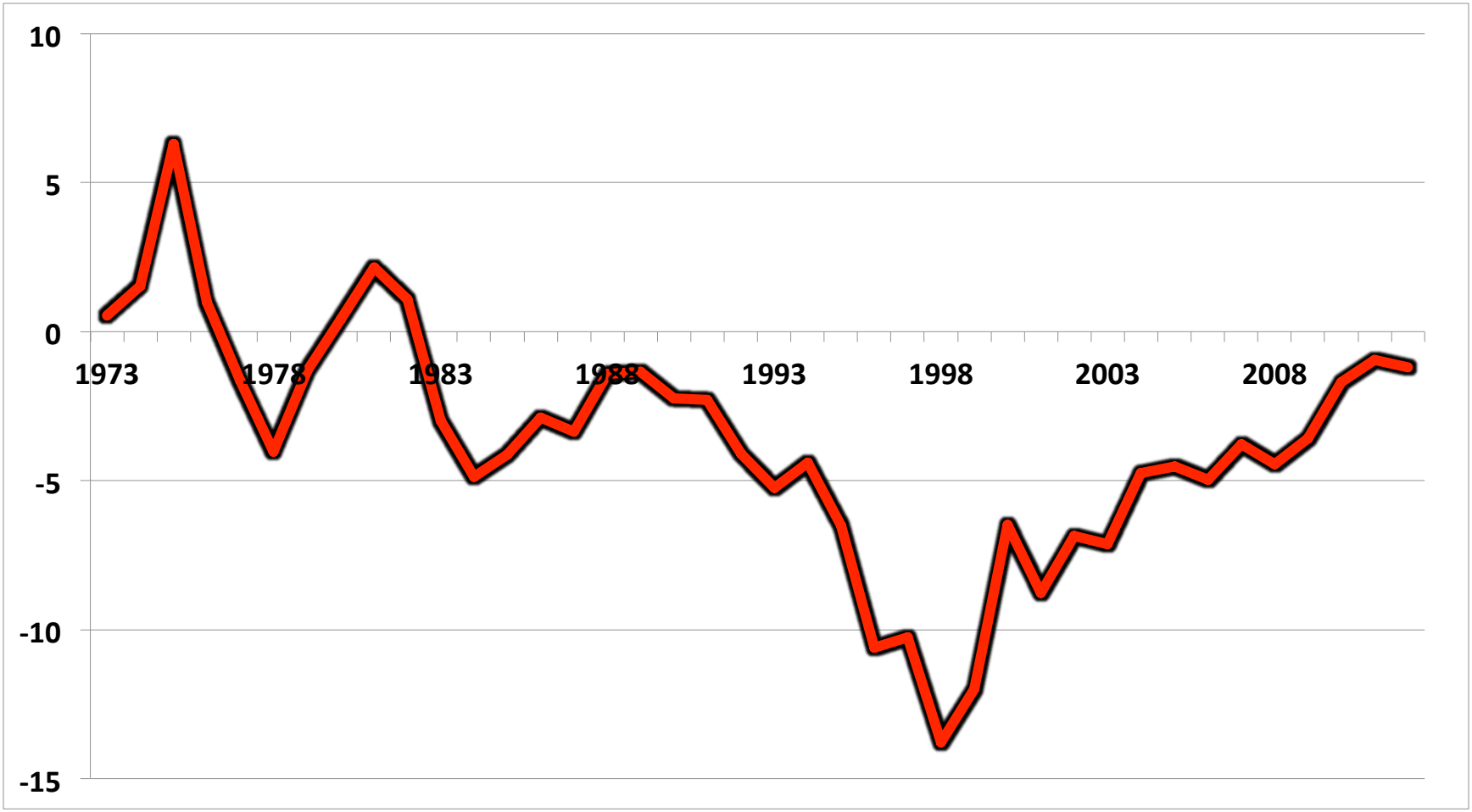
Growth in Manufacturing Capacity per capita has Turned Negative



The Most Dynamic Part of Manufacturing Has Disappeared



Annual Rate of Change of ICT Deflator



Are There Policy Solutions?

- **Demographics: index the retirement age to life expectancy and sharply raise quotas for legal immigration**
- **Reduce the share of the population in prison by legalizing drugs**
- **Education: impose higher standards in secondary school while investing in pre-school to reduce the "vocabulary gap"**
- **Inequality: return capital gains and dividend tax rates to pre-1997 levels.**
- **Make medical care a right of citizenship, not tied to employment status**
- **More generally, look north of the border**

Across Nations, Headwinds Are Not All Alike

- **Tuition last year at U of Toronto = $5600 per year**
- **My cousin's three e-mail comments:**
  - **"Canadians pay higher income and sales taxes. In return they get access to universal health care and reasonably priced university education."**
  - **"The U.S. has a far larger percent of its population in jails than is the case in Canada"**
  - **"The political system in the U.S. has become dysfunctional"**
- **Assignment for you: Comment on all of the above.**