

# **Interpretations of the Productivity Growth Slowdown**

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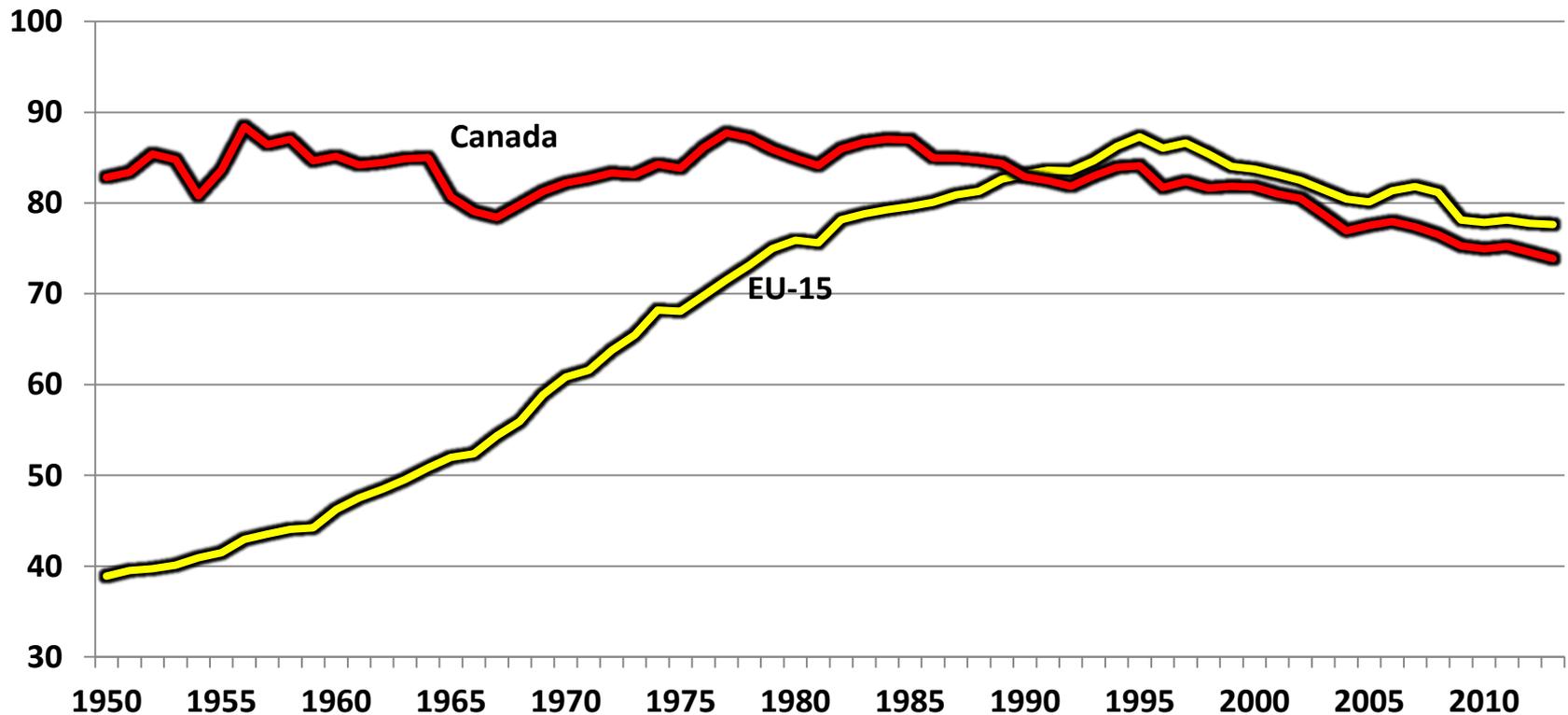
**Conference on the Productivity Growth  
Slowdown, Peterson Institute of International  
Economics, November 16, 2015**

# **Slowing Productivity Growth: Applies Not Just to US**

- **Slowing Productivity Growth in Two Phases**
  - (Total Economy) 1.1 and 0.5
- **Productivity Growth Even Slower in Canada, Europe, and Japan**
- **This talk is just about U.S.**
- **Universal slowdown suggests universal causes**

# Canada and the EU-15 Output per Hour Relative to the U.S., 1950-2013

Ratio of Canada and EU15 to U.S., Output per Hour, 1950-2013

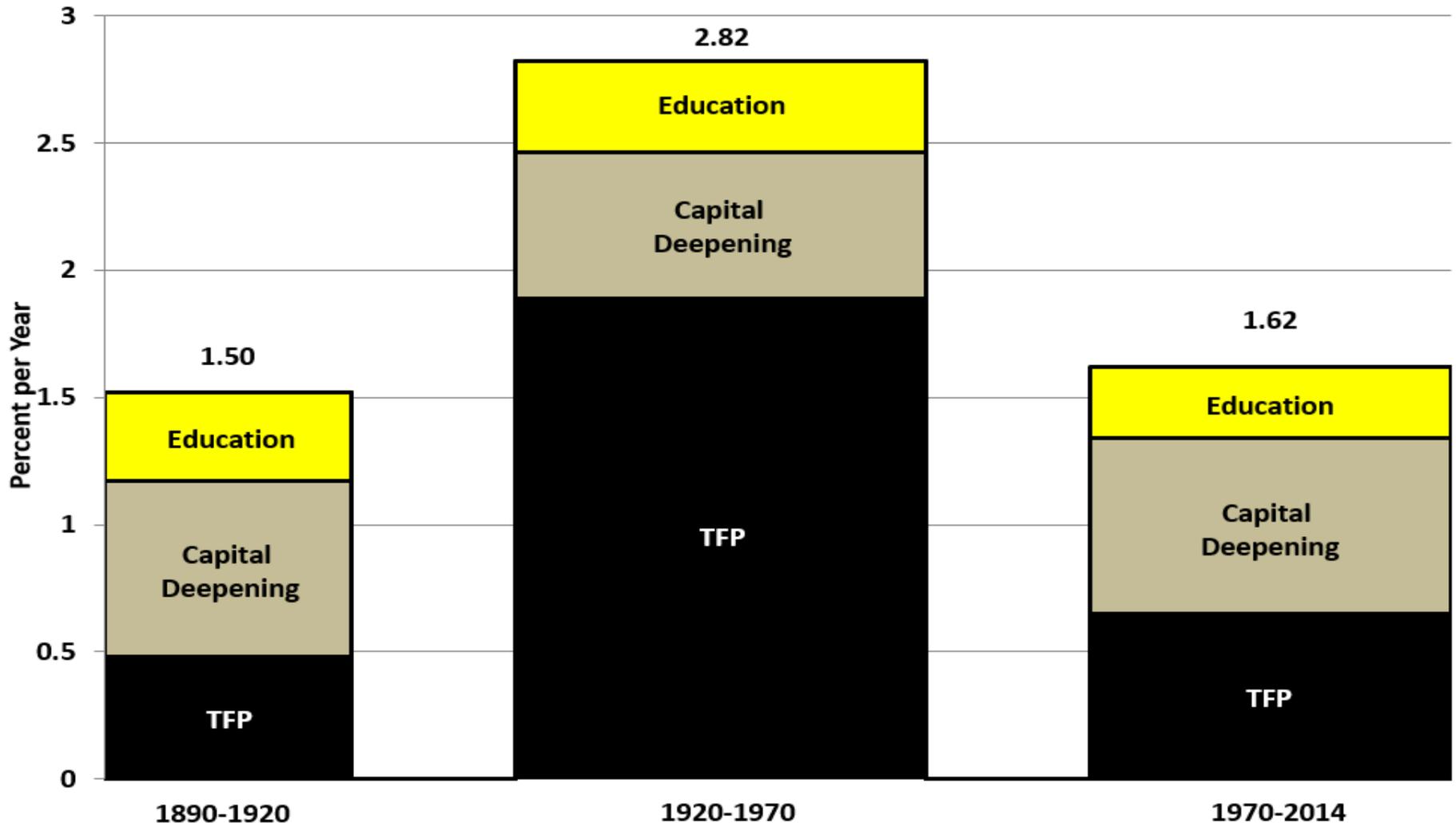


# Aspects of Productivity Slowdown

- **Dimensions, starting back in 1870**
  - 1870-2014, three historical era
  - 1950-2015, four sub-eras
- **TFP Measures Impact of Innovation**
  - The Three Industrial Revolutions, different impact
- **Was the Great Recession the Cause?  
Hysteresis?**
- **Potential for Measurement Error**

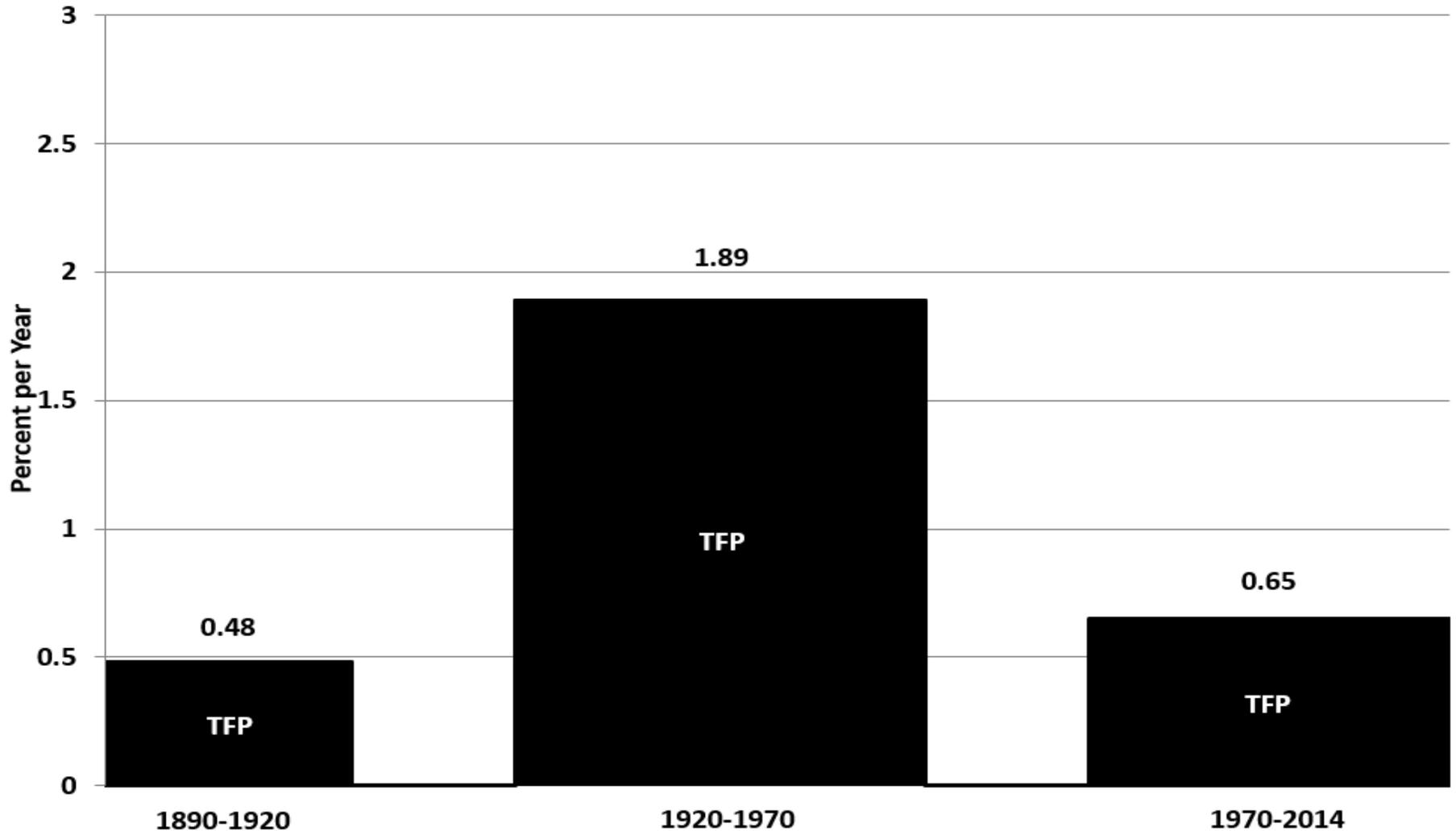
# The Three Eras of Productivity Growth

Figure 1-2. Average Annual Growth Rates of Output per Hour and Its Components, Selected Intervals, 1890-2014



# The Three Eras of TFP Growth

Figure 1-2. Average Annual Growth Rates of Total Factor Productivity, Selected Intervals, 1890-2014



# Slowing TFP Growth Is the Source of Secular Stagnation

- The history of TFP growth is the best guide to the importance of invention and innovation
- Study of innovation distinguishes among the industrial revolutions (IR #1, IR #2, IR #3).
- *The 1<sup>st</sup> IR occurred 1770-1840, continued impact through 1900*
  - Steam engine, railroad, steamships, wood=>steel

# **The 2<sup>nd</sup> IR Occurred 1870-1920, Continued Impact through 1970**

## ***– At least 6 dimensions***

- Electricity: light, elevators, machines, air conditioning**
- Internal combustion engine: vehicles, air transport**
- EIC: Telephone, phonograph, movies, radio, TV**
- Running water, sewer pipes, and the conquest of infant mortality**
- Chemicals, plastics, antibiotics, modern medicine**
- Utter change in working conditions, job & home**

# **Why Did Productivity Grow Faster During 1920 - 1970? The One-Time-Only Inventions**

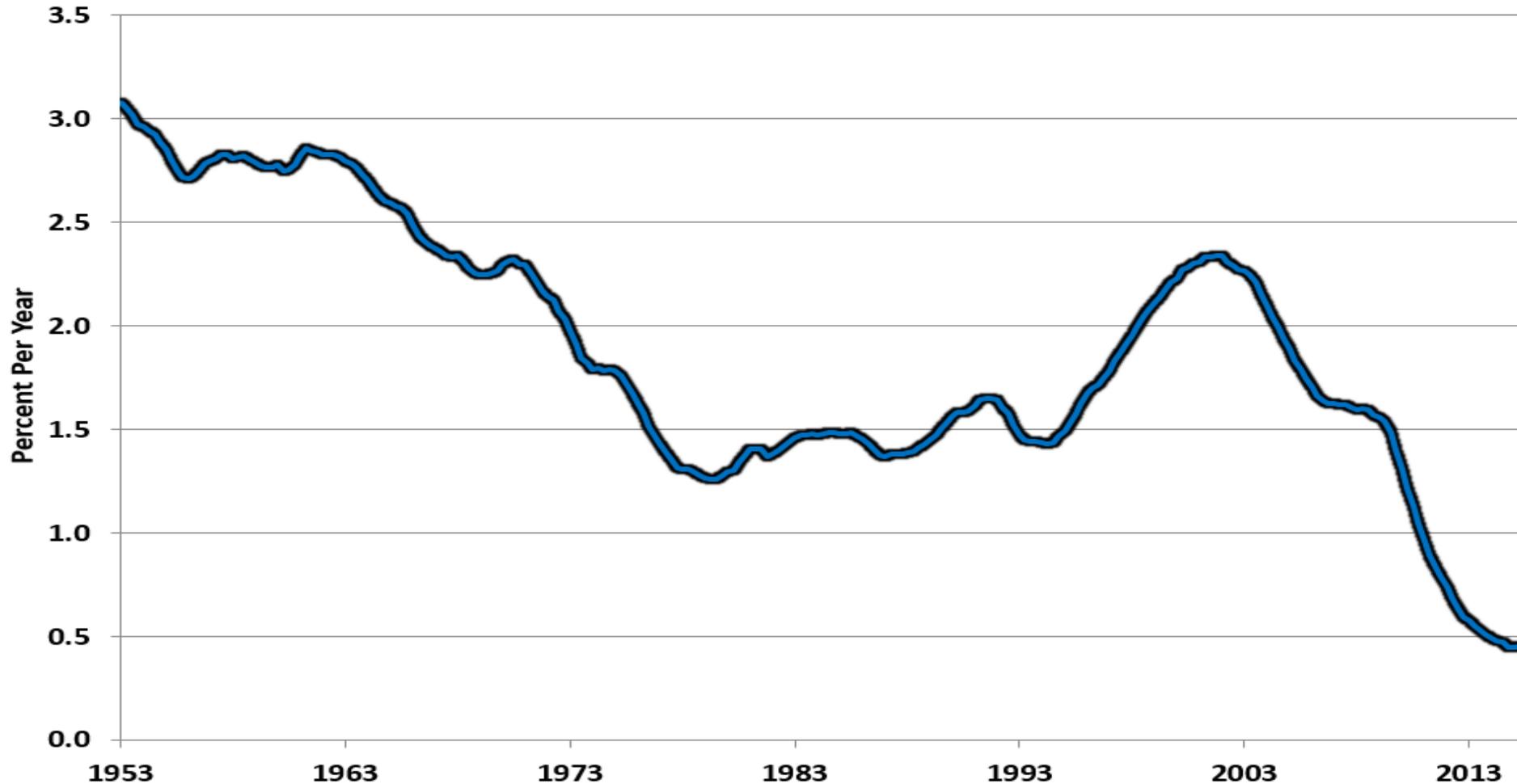
- Polluting flames for light >> instant on-off electric light**
- Factory power with steam engines and belts >> electric machine tools and hand tools**
- Offices and home cold and hot >> central heating and air-conditioning**
- Horses >> motor vehicles and air travel**
- Mainly rural 1870 >> mainly urban 1950**

# **Changes in Standard of Living Not Included in GDP**

- Carrying pails of water >> running water**
- Outhouses >> indoor bathrooms**
- Infant mortality 20% >> infant mortality 1%**
- Child labor. 1890 almost half of 14-15 year old boys were in the labor force >> almost none after 1940**
- Isolation -> telephone + phonograph + radio + TV**
- Model T vs. no autos in CPI until 1935**

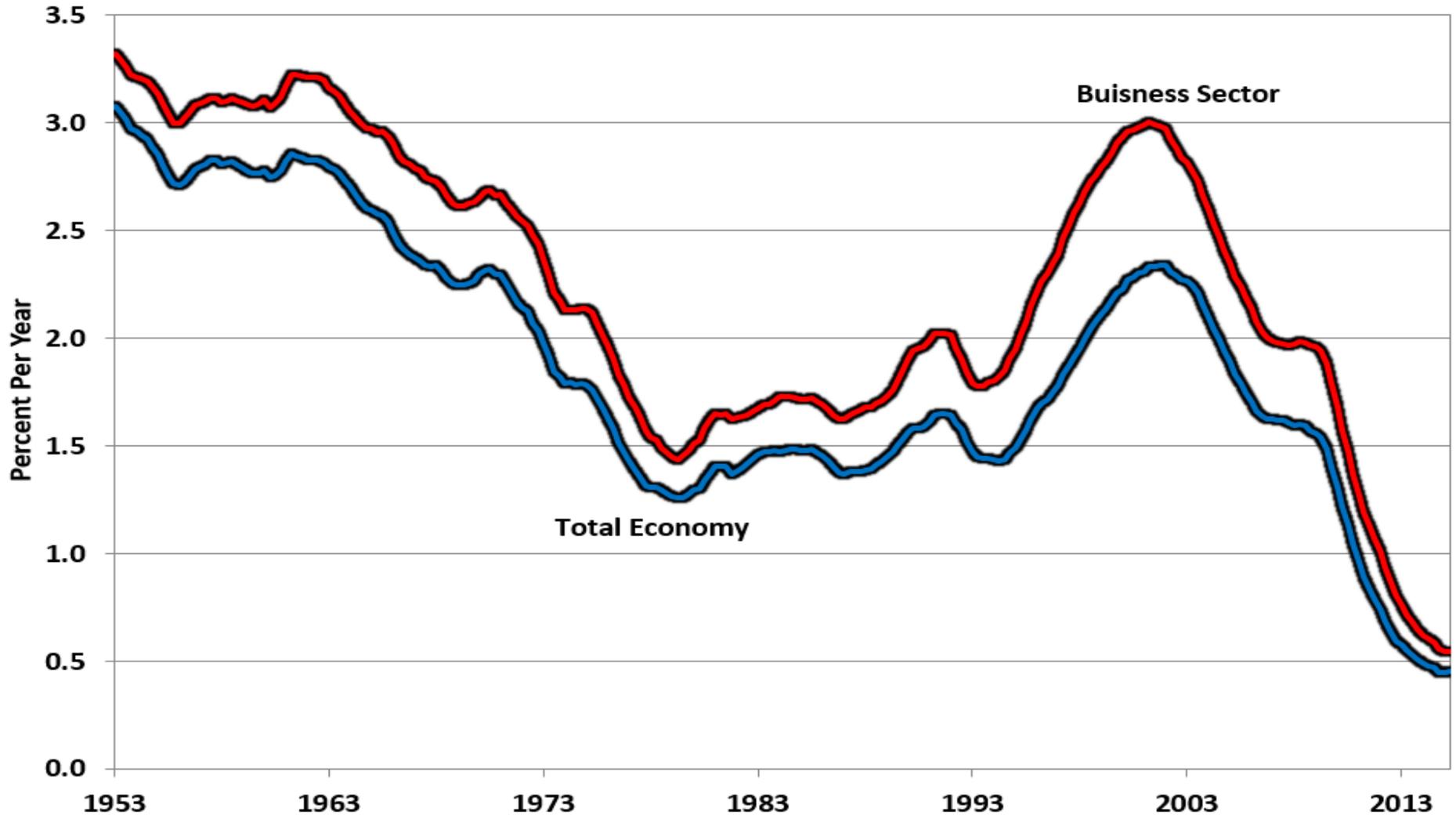
# Post-1950 Kalman Trend in LP Growth, Total Economy

Kalman Trend Annualized Growth in Total Economy Productivity,  
Quarterly, 1953Q1-2015Q2



# Business Sector vs. Total Economy

Figure 1. Kalman Trend Annualized Growth in Measures of Productivity, Quarterly, 1953Q1-2015Q2



# **IR #3 Changed Business Practices Completely 1970-2005**

- **How profound was the change, how little has changed in past decade**
  - **1970 mechanical calculators, repetitive retyping, file cards, filing cabinets**
  - **1970s and 1980s. Memory typewriters, electronic calculators, PCs with word processing and spreadsheets. Terminals accessing mainframe data.**
  - **1990s. The web, search engines, e-commerce**
  - **2000-05 flat screens, revolution in business practices was over. End of era of paper and file folders.**

# Paper to Electronic Catalogs

- **Transformation from 1985 to 2005**
  - University and public libraries
  - Parts departments at auto dealers
  - Ordering items at hardware stores
  - Selecting plants at nurseries/ garden shops
- **All of these uses have in common**
  - Not only are items listed and pictured
  - Available inventory, out-of-stock is indicated
  - Same information available at home as in store

# **Sameness in Travel, How Much Has Changed Since 2005?**

- **Checking in for an airline?**
  - E-kiosks rolled out 2001-04
  - Gate personnel, in flight unchanged
- **Checking in at a hotel?**
  - Hotel room service
  - Hotel convention room set-up and service
- **Checking in for a car rental?**
  - Frequent renter service 20 years ago
  - Car maintenance, cleaning

# **More Achievements Completed by 2005**

- **Finance and Banking**
  - 1970s and 1980s, ATM machines
  - 1980s and 1990s. Transition from multi-million share trading days to multi-billion share days
  - Commonplace now: empty bank branches
- **How Long Ago Were the Creations:**
  - Amazon 1994, Google 1998, Wiki and i-tunes 2001, Blackberry 2003, Facebook 2004, iPhone 2007

# **Summary: Stasis Everywhere You Look**

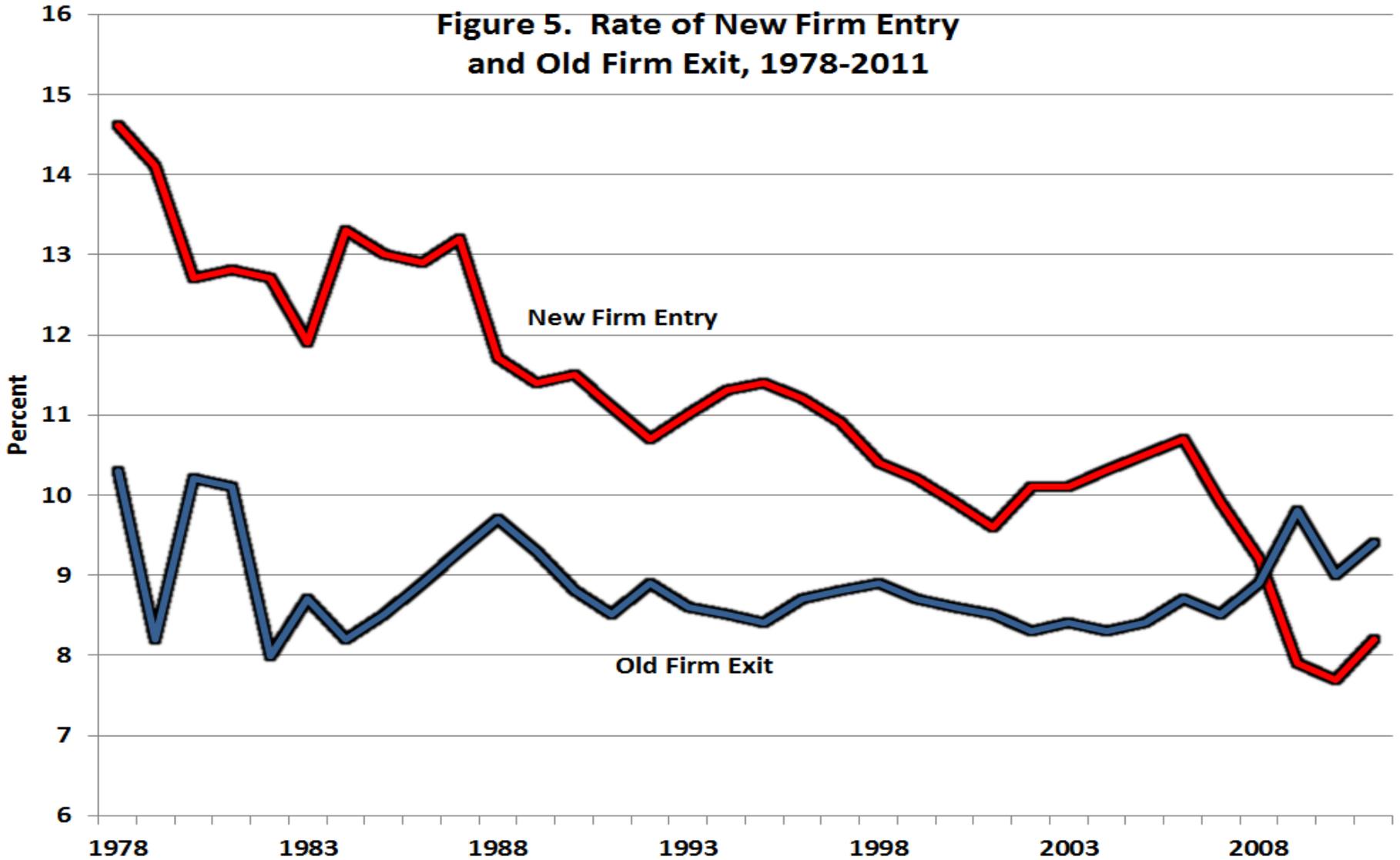
- **Offices use desktop computers with proprietary and web information much as they did 10-15 years ago**
- **Retail stasis. Shelves stocked by humans, meat sliced at service counters, checkout bar-code scanning by humans**
- **Medicine: electronic medical records largely rolled out, little change in what nurses and doctors do**
- **Higher Education: cost inflation comes from rising ratio of administrative staff to instructional staff**

# **Additional Evidence of Diminishing Returns**

- **Decline in Business “Dynamism”**
  - Decline over last 30 years in creation of new firms
  - In recent years more exiting firms than entering firms
- **Decline in labor market “Fluidity”**
  - Decline in job and worker reallocation rates

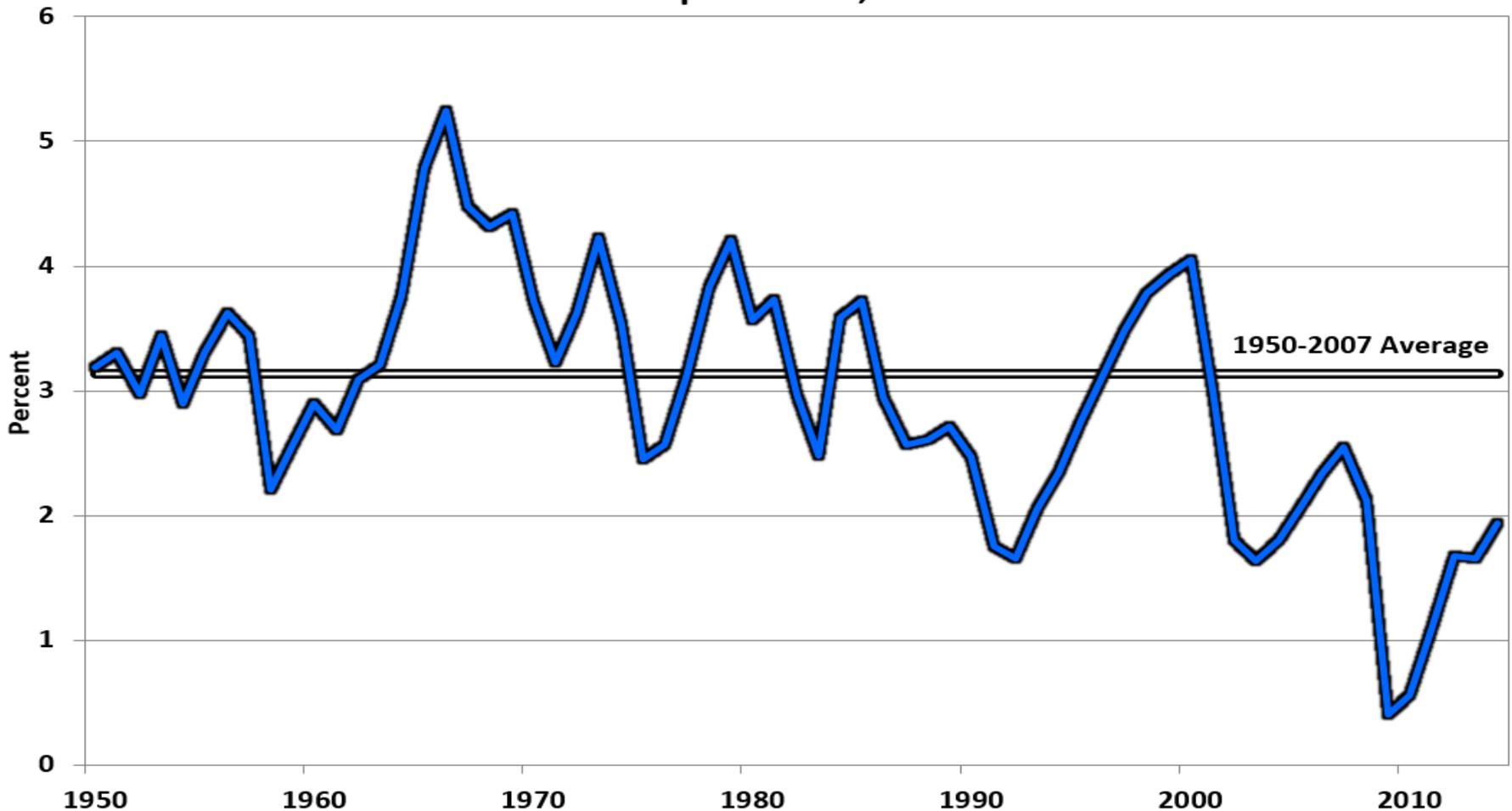
# Business “Dynamism” Represented by New Firm Entry

Figure 5. Rate of New Firm Entry  
and Old Firm Exit, 1978-2011



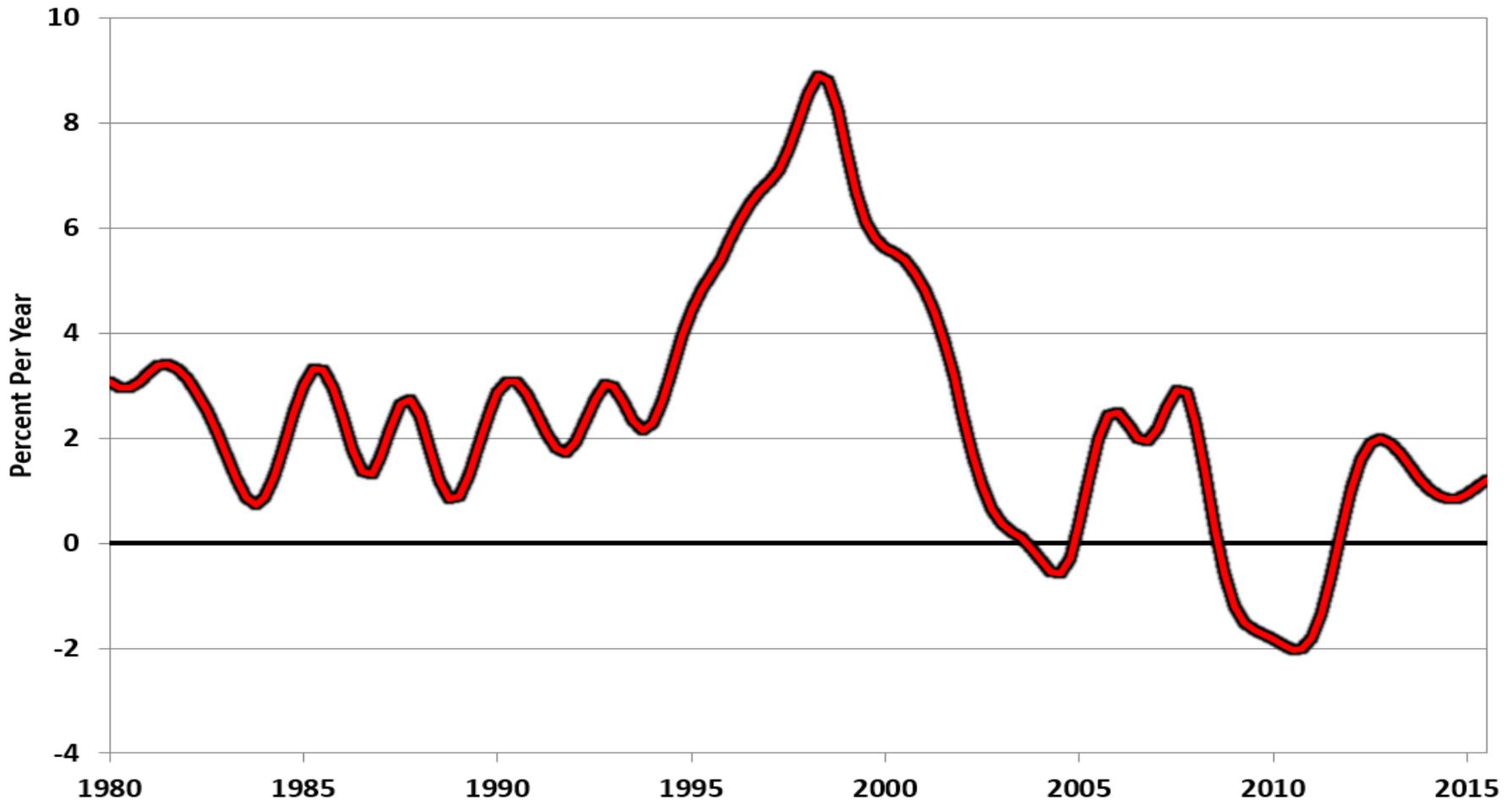
# Stagnation Symptom #2: Declining Rate of Net Investment

Figure 17-6. Annual Ratio of Net Private Business Investment to Private Business Capital Stock, 1950-2014



# Stagnation Symptom #3: Growth in Manufacturing Capacity

Figure 17-5. Quarterly Annualized One-Year Change in Manufacturing Capacity, 1980-2015



# **Innovations Continue But How Important Are They?**

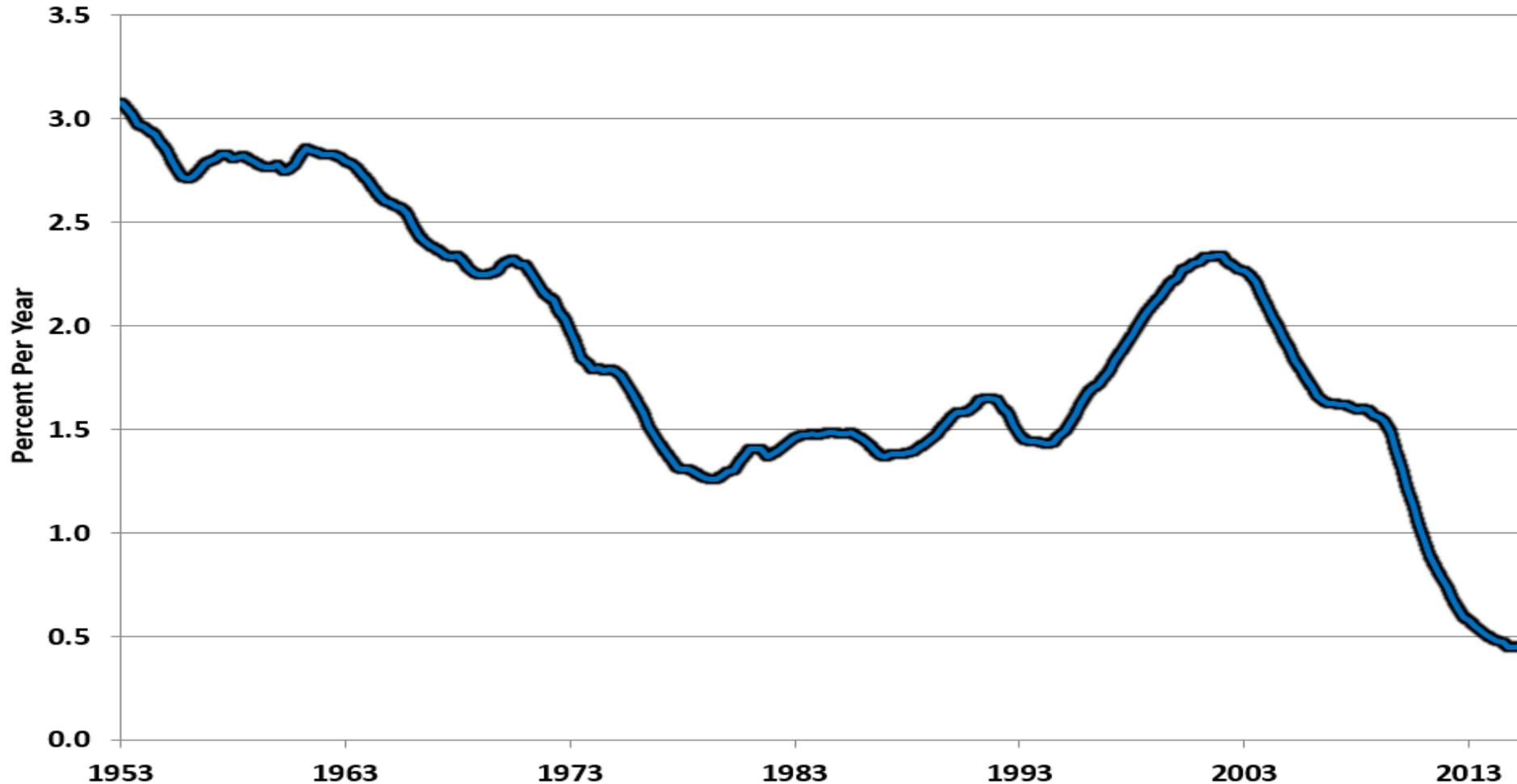
- **Small Robots**
  - **Robots date back to 1961, continued development is evolutionary not revolutionary**
  - **Amazon robots are not as smart as you might think**
  - **Robot description**

# **Innovations Continue But How Important Are They?**

- **Big Data and Artificial Intelligence**
  - Predominant uses of big data are in marketing, zero-sum game
  - Application to legal searches, radiology reading evolutionary, not revolutionary
  - Next wave of replacement of humans: personal financial services (“Robo-advice”) and insurance agents
- **Driverless Cars and Trucks**
  - Truck drivers don’t just drive trucks, they unload them and stock the shelves
  - Delivering the bread, beer, and coke. Picking up the garbage

# Post-1950 Kalman Trend in LP Growth, Total Economy

Kalman Trend Annualized Growth in Total Economy Productivity,  
Quarterly, 1953Q1-2015Q2



# Past and Future Productivity Growth

**Table 18-3**  
**Actual and Forecast Growth Rate**  
**of Output per Hour, 1948-2040**

	<b>Actual Growth</b>	<b>Education Adjustment</b>	<b>Growth Net of Education Adjustment</b>
<b>1. 1948-1970</b>	<b>2.71</b>		
<b>2. 1970-1994</b>	<b>1.54</b>		
<b>3. 1994-2004</b>	<b>2.26</b>		
<b>3. 2004-2015</b>	<b>1.00</b>		
<b>4. Weighted Average of 1970-94 and 2004-15</b>	<b>1.38</b>	<b>-0.30</b>	<b>1.08</b>
<b>5. Forecast Growth 2015-40</b>			<b>1.20</b>

# The Mismeasurement Hypothesis

- **Growth Rates, Total Economy Productivity:**
  - 1994-2004      2.3
  - 2004-2015      1.1
  - 2010-2015      0.5
- **For mismeasurement to be the explanation, would have to explain  $2.3 - 0.5 = 1.8$**
- **Alternatively, pre/post 2004  $2.3 - 1.1 = 1.2$**

# **Post-Boskin Improvements in the CPI**

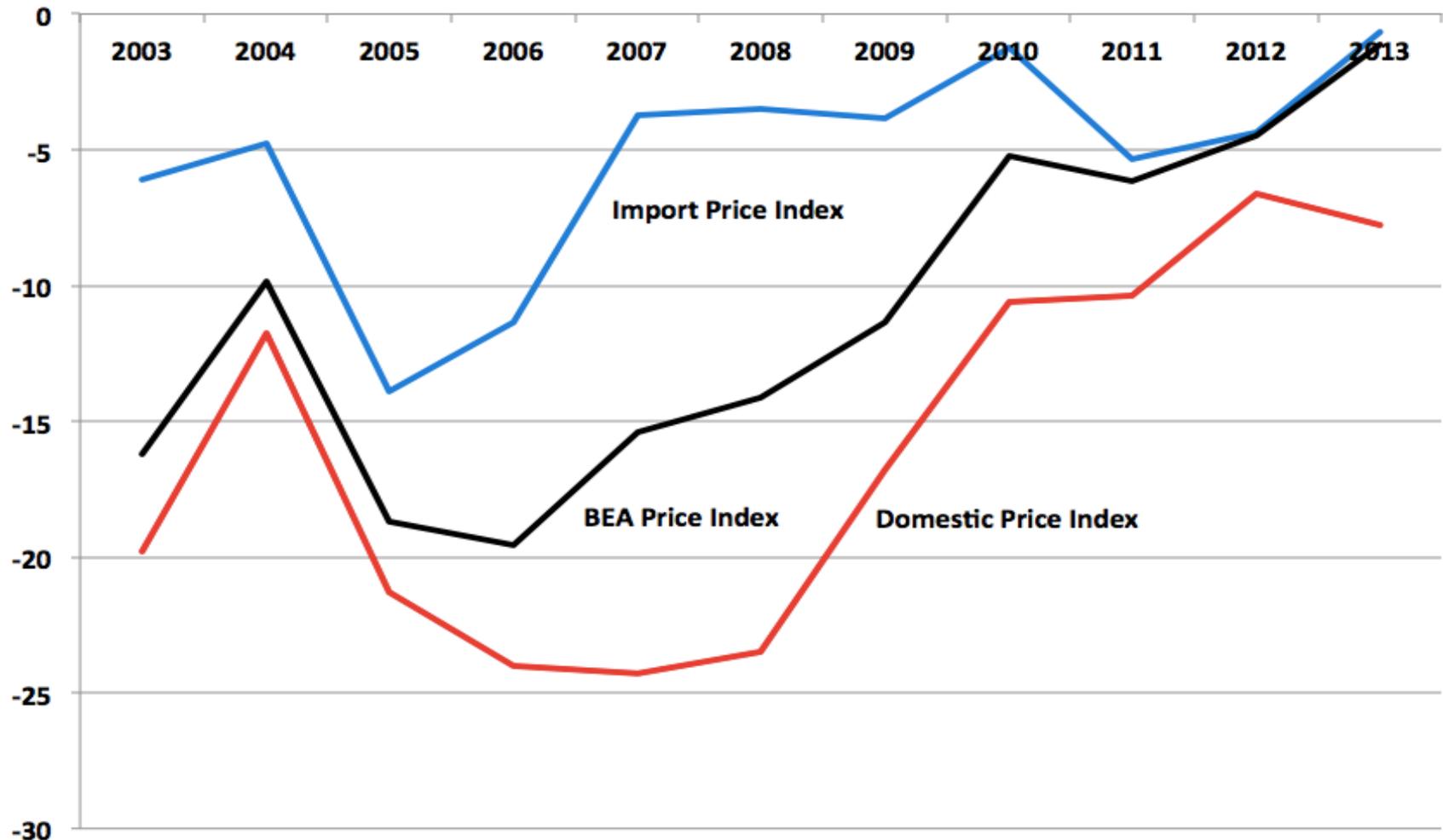
- **Source: Johnson, Reed, and Stewart (2006)**
- **Reduction of lower-level substitution bias, 0.2 to 0.3**
- **Updated market basket, 0.05**
- **Improved quality change, e.g., hedonic price indexes for TVs, audio equipment. No net change**
- **Implied total improvement,  $0.25 + 0.05 = 0.30$**
- **Also new: chained CPI, but GDP already chained**

# Computer Prices

- **Matters for GDP deflator and hence real GDP, thus labor productivity**
- **Bryne-Oliner-Sichel on semiconductor prices**
  - **Change of Intel pricing strategy invalidates matched-model indexes**
  - **PPI -8% per year vs. B-O-S -43% per year**
- **This is picked up by Hatzius-Dawsey for final computer output**
  - **They assume  $\frac{3}{4}$  of slowdown in change of computer prices is fictitious**

# Three Price Indexes for Computers and Peripherals

Figure 4. Alternative Price Indexes for Computer Equipment

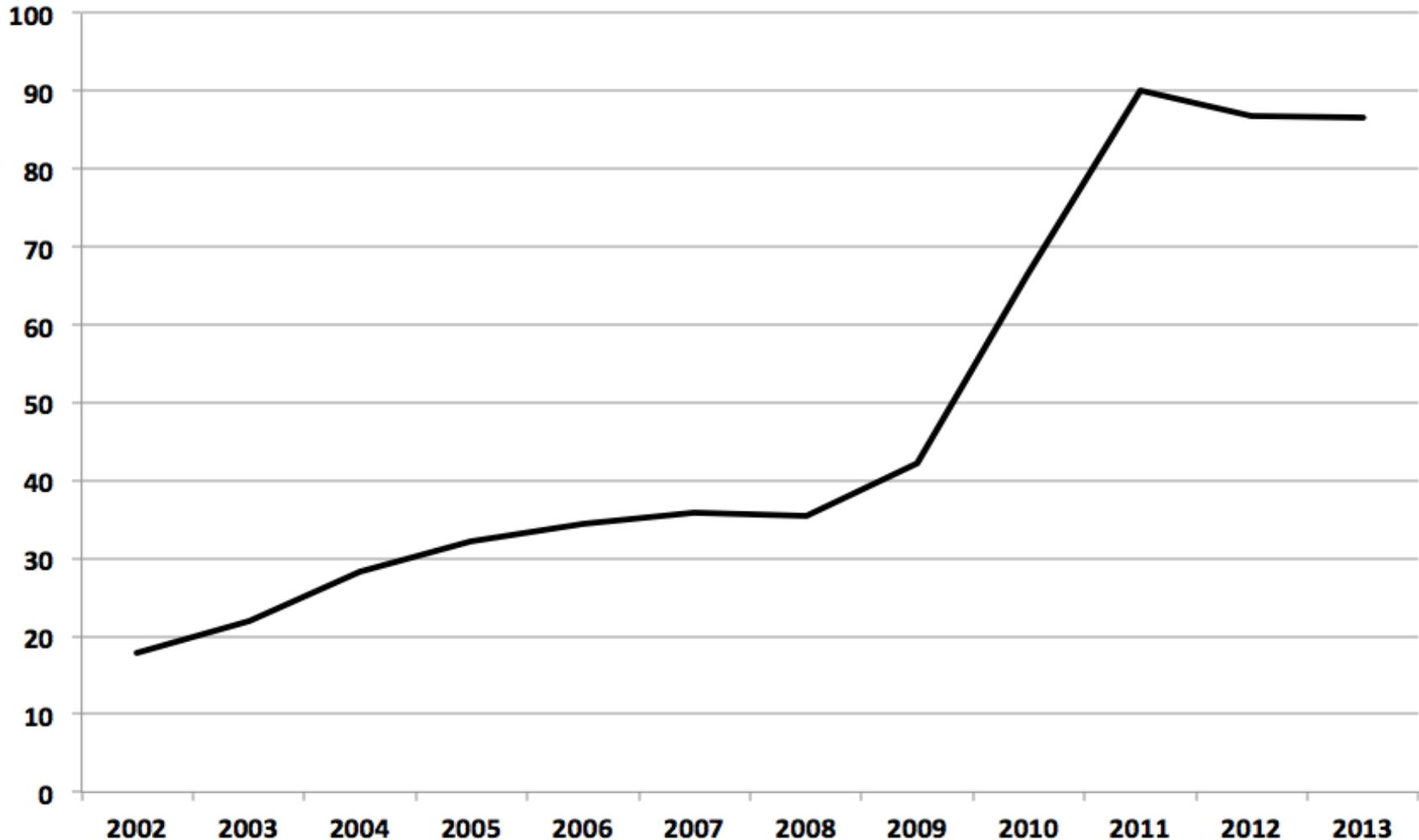


# Two Issues with Import Price Index for Computers

- **It must be wrong.**
  - Imported computers are not getting steadily more expensive than domestically produced
  - If anything, reverse is true
- **Let's say IPI is wrong**
  - $IPI = \text{domestic PPI}$  implies  $BEA = \text{domestic PPI}$ .
  - No impact on GDP. More investment but more imports
  - More capital deepening, slower growth TFP

# The Stunning Implications of the Import Takeover

Figure 3. Import Percentage of Computer Equipment Investment



# **Import Penetration in 2011-13 Equals 88%**

- **To simplify, say it's 100%**
- **That means that computer output is no longer part of GDP**
  - **Any price index bias is irrelevant for GDP**
  - **But raises contribution of capital deepening to productivity growth**
  - **Thus reduces contribution of TFP to productivity growth**
- **Same is true of communication equipment, where Bryne and Corrado have also found substantial price index bias**

# **A Longer Time Span of Computer Price Index Bias**

- **Nordhaus, JEH 2007**
  - Performance measure vs. input measure in hedonics
  - 1969-2004. Nordhaus -51%, BEA -19%
  - Pricing different things
  - Nordhaus catches transition mainframes to PCs
- **Let's say bias is 25%.**
  - Share of GDP declined 1.2% in 2000 to 0.4% in 2015
  - This contributes 0.3 reduction in downward bias of real GDP growth from 2000 to 2015

# The Biggest Issue: Free Internet Services

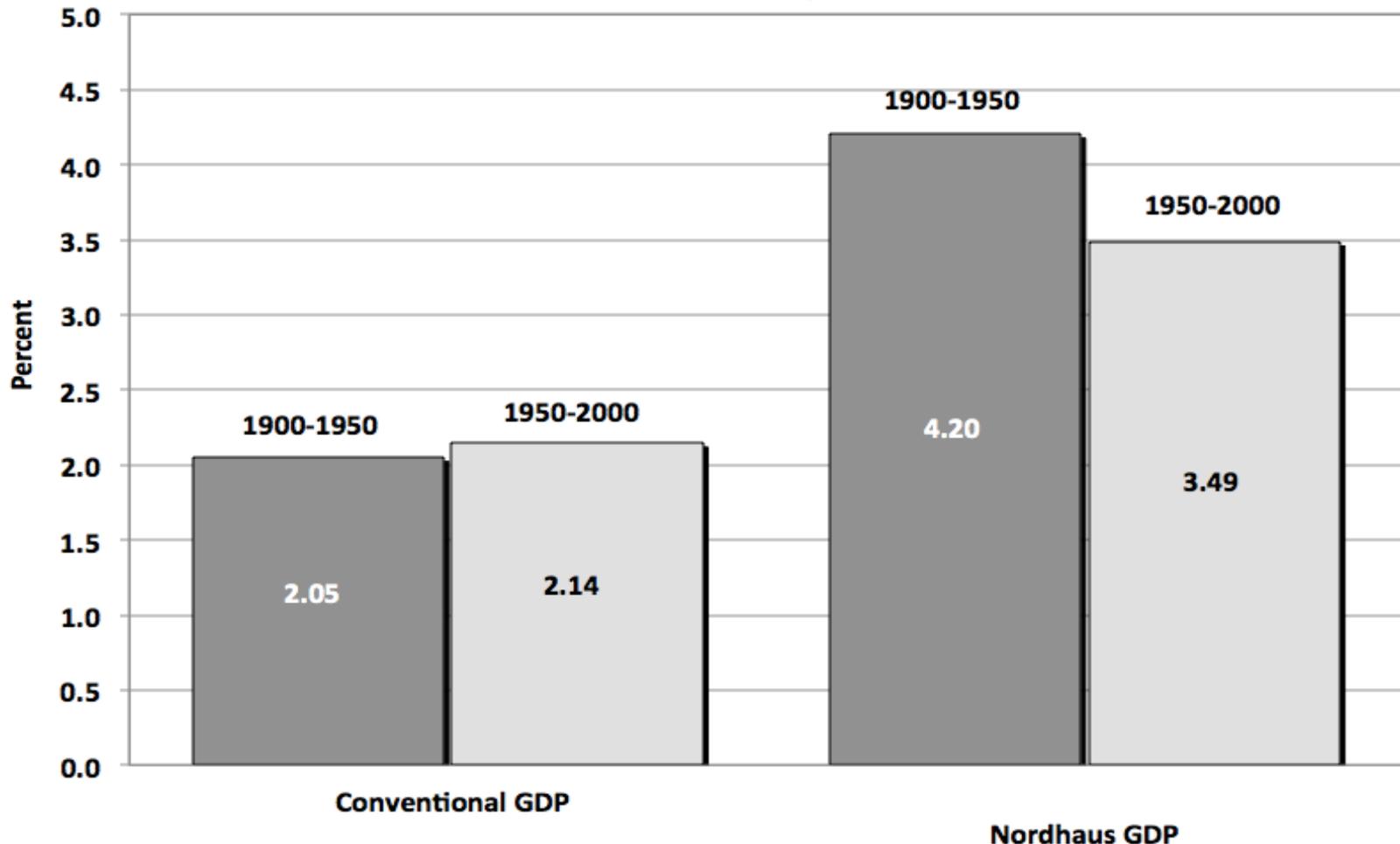
- **Hatzius-Dawsey copy 0.75% from Brynjolfsson-Oh**
  - Measured by multiplying wage by hours of use
  - Half of population not employed
  - Ignores declining marginal utility of leisure
  - Annual growth of current value should be run back to 1995
- **My estimate is 0.2%, but plenty of room for it to be higher**

# **History: The Enormous Gains in Unmeasured Consumer Surplus**

- **Electric light, elevator, streetcars, subways, appliances, air conditioning**
- **Internal combustion engine, autos, trucks, busses, elimination of horse droppings**
- **Telephone, phonograph, radio, motion pictures, TV**
- **Running water, waste disposal**
- **Brutal working conditions on the farm and in the factory, esp. 72-hr-week steel mills**
- **Nordhaus on value of improved life expectancy**

# Life Expectancy and Unmeasured GDP Growth

Figure 5. Average Annual Growth Rate in Per Capita GDP With and Without the Accumulation of Health Capital, 1900-1950 and 1950-2000



# **Conclusion on Measurement: No Evidence of an Increase of Upward Bias**

- **CPI improvements 0.3**
- **Reduction in computer bias 0.3**
- **Opposite direction: free internet services**
  - 0.2? 0.4?
- **The productivity growth slowdown is real**
- **Why?**
  - **The business methods and retail revolutions boosted productivity growth 1980-2005. Stasis since 2005**
- **2/3 all TFP growth since 1870 occurred 1920-70**