

The Sources of Slowing Growth in Productivity Growth and Potential Output

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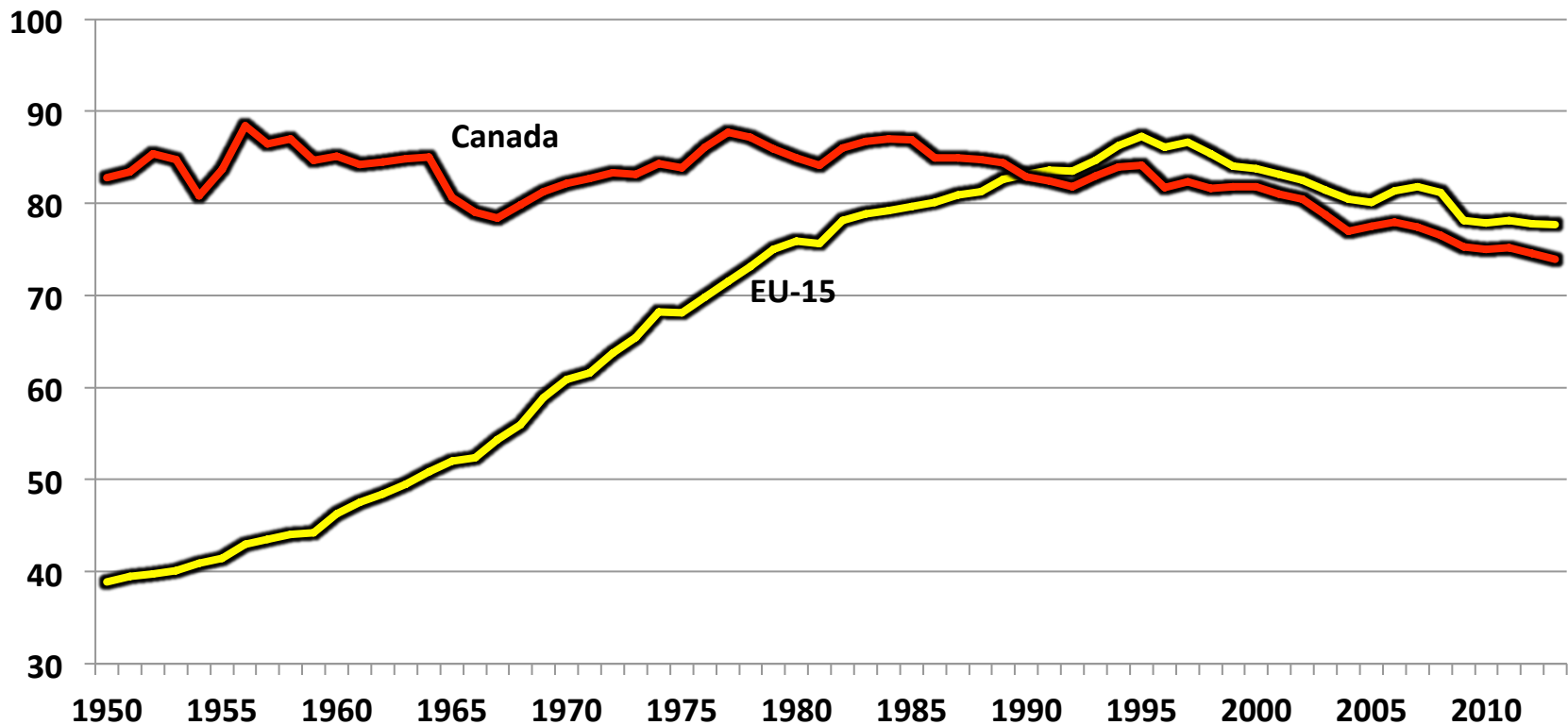
December 4, 2015

Slowing Productivity Growth: Applies Not Just to US

- **Slowing Productivity Growth in Two Phases**
 - (Total Economy) 2.3 to 1.1 to 0.5
- **This talk is just about U.S.**
- **Productivity Growth Even Slower in Canada, Europe, and Japan**
- **Universal slowdown suggests universal causes**

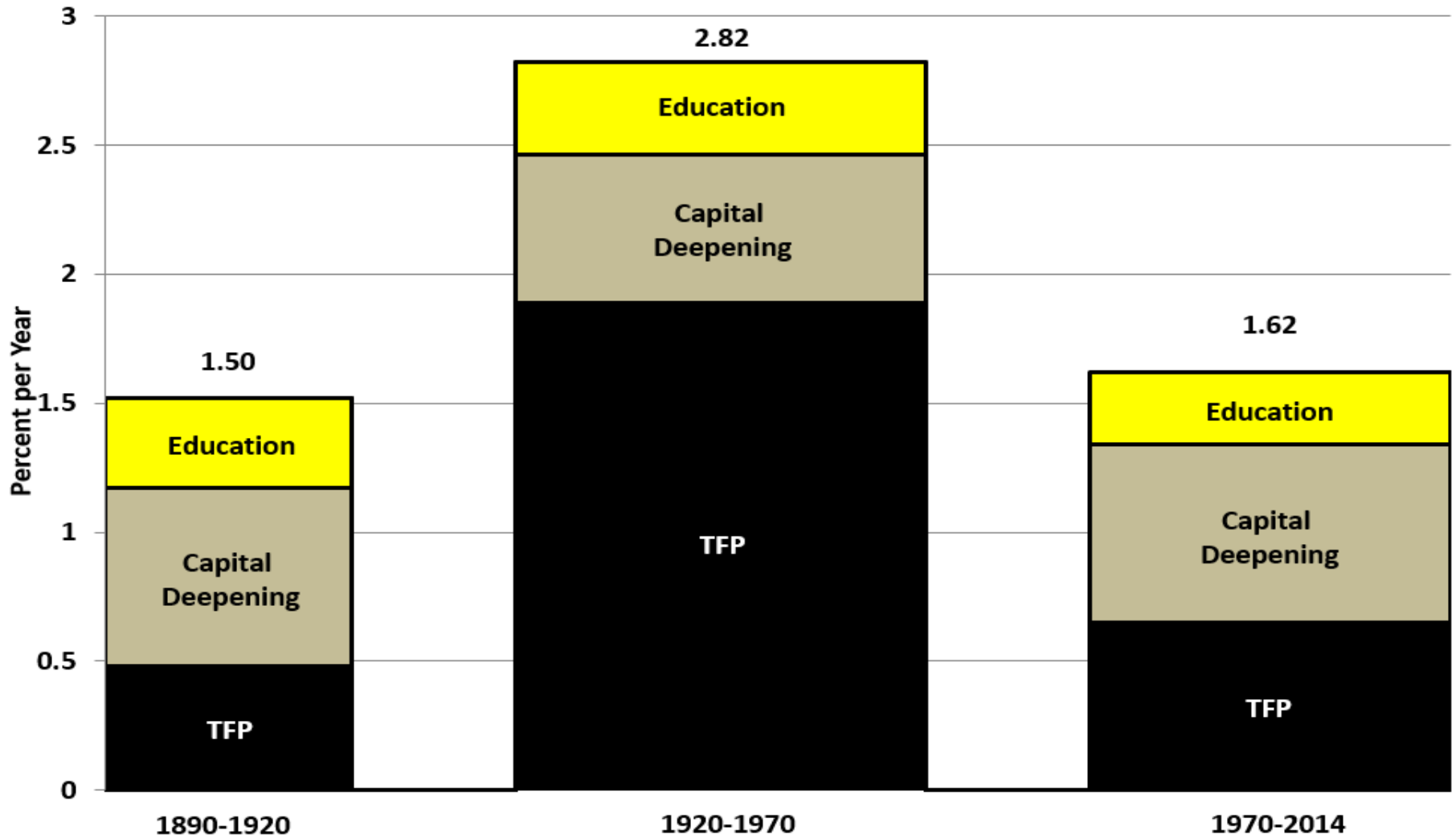
Canada and the EU-15 Output per Hour Relative to the U.S., 1950-2013

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



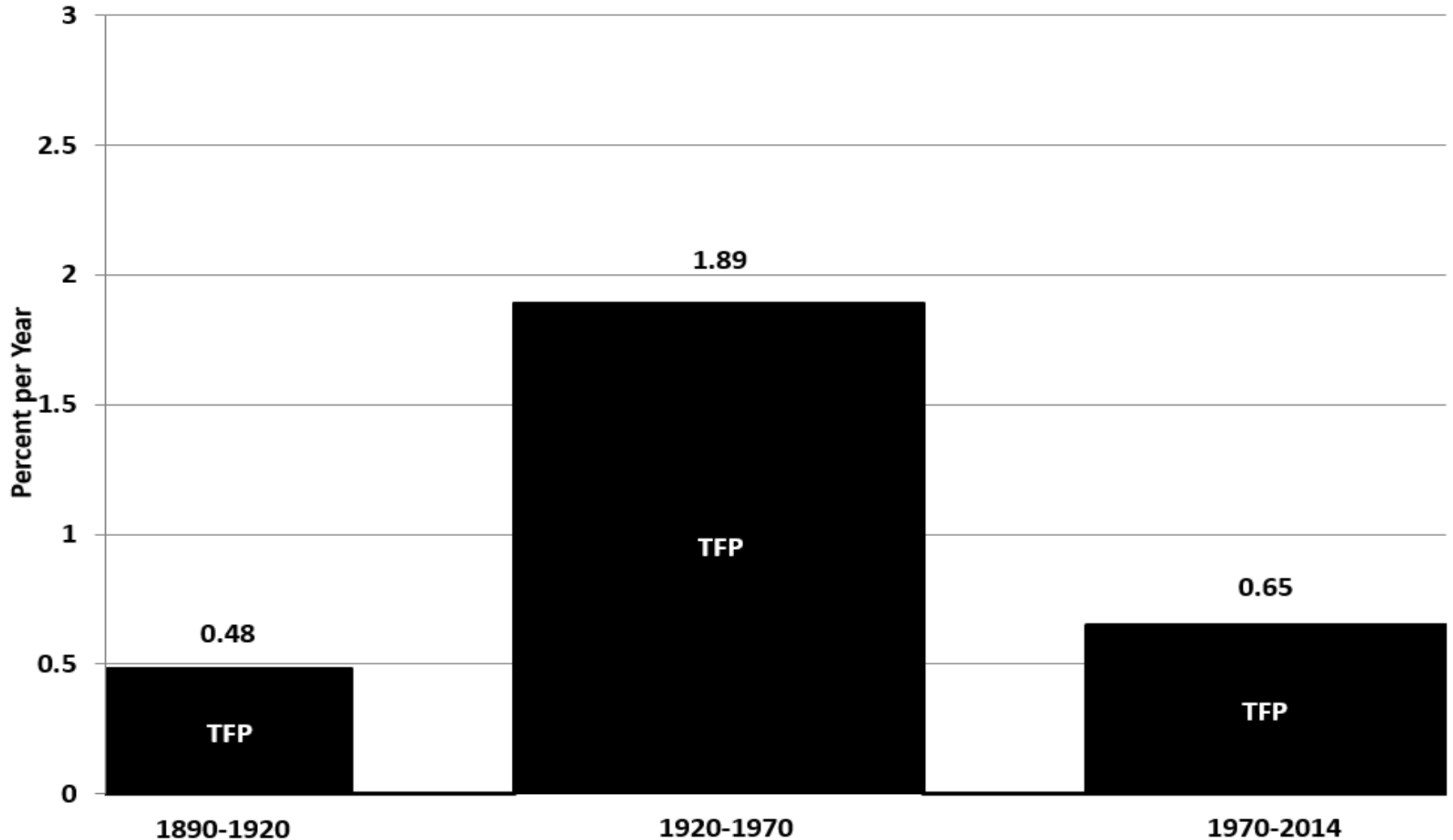
The Three Eras of Productivity Growth

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 1st IR occurred 1770-1840, continued impact through 1900*
 - Steam engine, railroad, steamships, wood=>steel

The 2nd IR Occurred 1870-1920, Continued Impact through 1970

– *At least 6 dimensions*

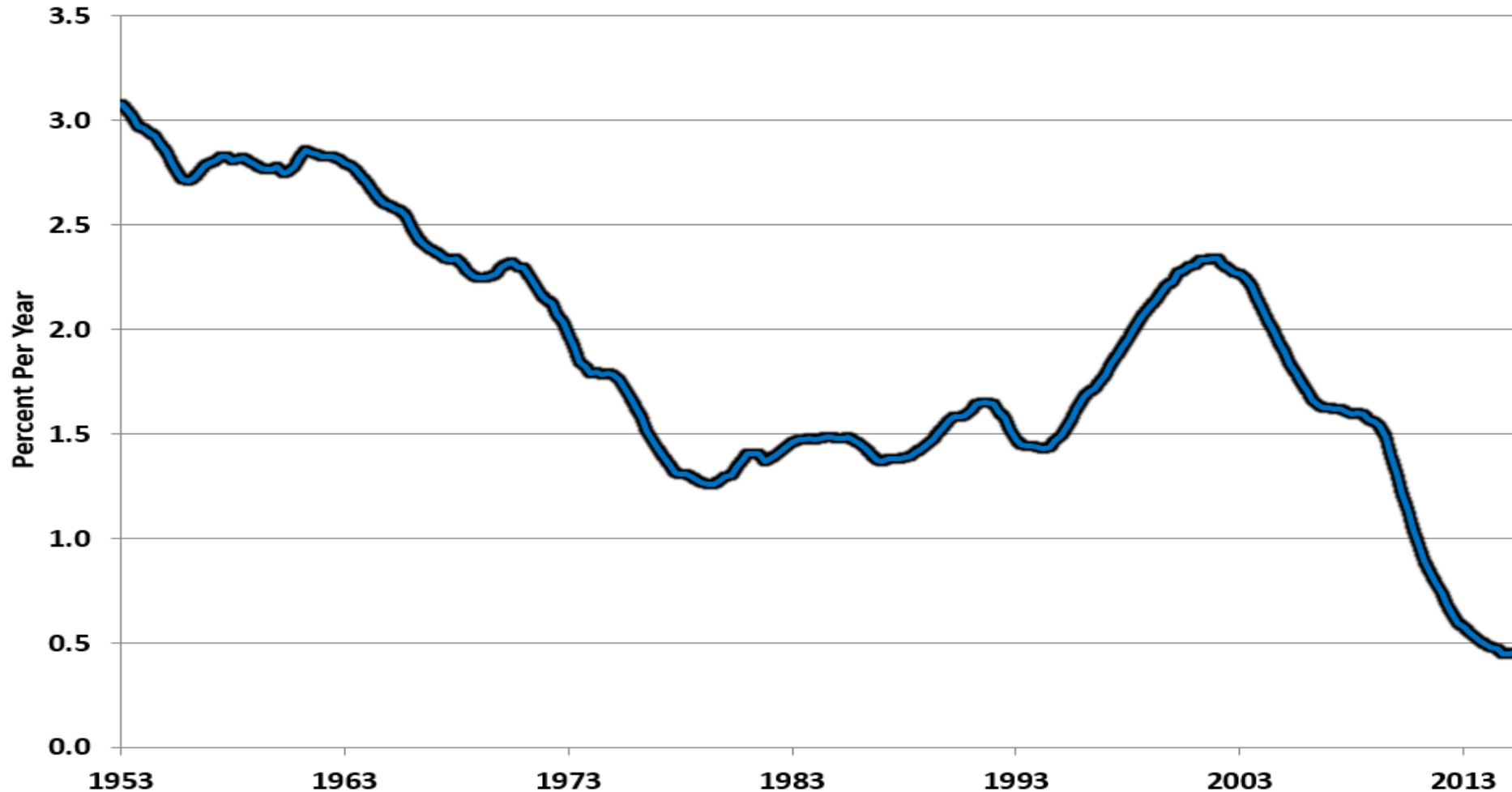
- **Electricity: light, elevators, machines, air conditioning**
- **Internal combustion engine: vehicles, air transport**
- **EIC: Telephone, phonograph, movies, radio, TV**
- **Running water, sewer pipes, and the conquest of infant mortality**
- **Chemicals, plastics, antibiotics, modern medicine**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

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**
- Work and home from cold and hot to uniform temperature due to central heat & air conditioning**

Post-1950 Kalman Trend in LP Growth, Total Economy

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



How to Interpret the 1995-2004 Productivity Growth Revival Followed by Growth Slowdown?

- **Comparing 1970 with 2005, there was a quantum leap increase in the LEVEL of labor productivity**
- **This translates into a temporary hump in the GROWTH RATE of labor productivity**
- **Let's be specific about the advances that created the quantum leap**

IR #3 Changed Business Practices Completely 1970-2005

- **1970 mechanical calculators, repetitive retyping, file cards, filing cabinets**
- **1970s and 1980s. Memory typewriters, electronic calculators, PCs with word processing and spreadsheets.**
- **1990s. The web, search engines, e-commerce**
- **2000-05 flat screens became ubiquitous**
- **Walking around, you see those same flat screens – dr, dentist, vet, pharmacy**

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

Eliminating the Middle in Publishing

- **Movie “The Paper” vintage 1994**
 - A newsroom of PC screens (not flat)
 - By then no linotype operator
- **Newspapers, magazines, books, academic papers**
- **The whole layer of secretaries, typesetters, middlemen had been eliminated**

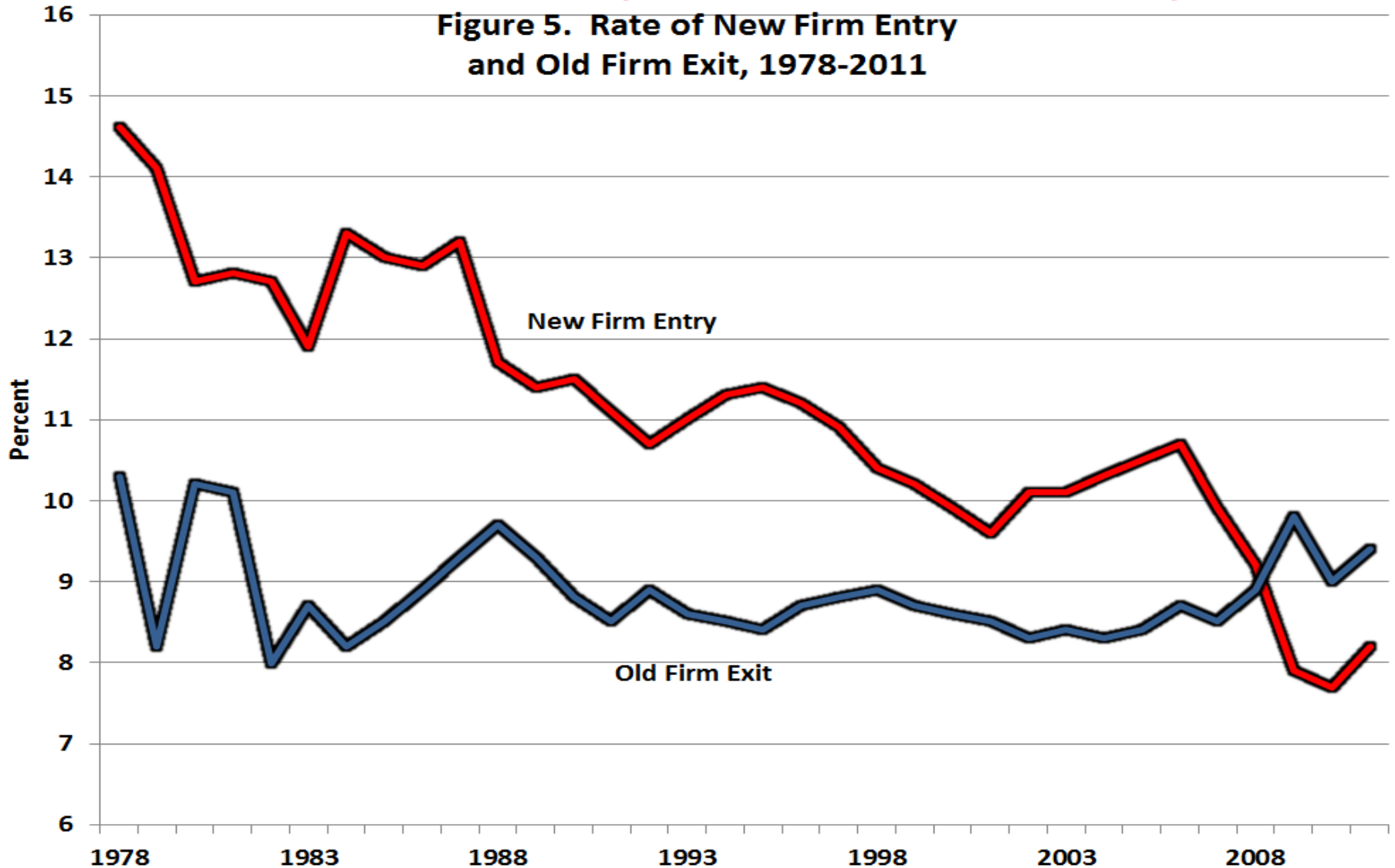
Sameness in Travel, How Much Has Changed Since 2005?

- **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

Summary: Stasis in How Business Operates Day-to-Day

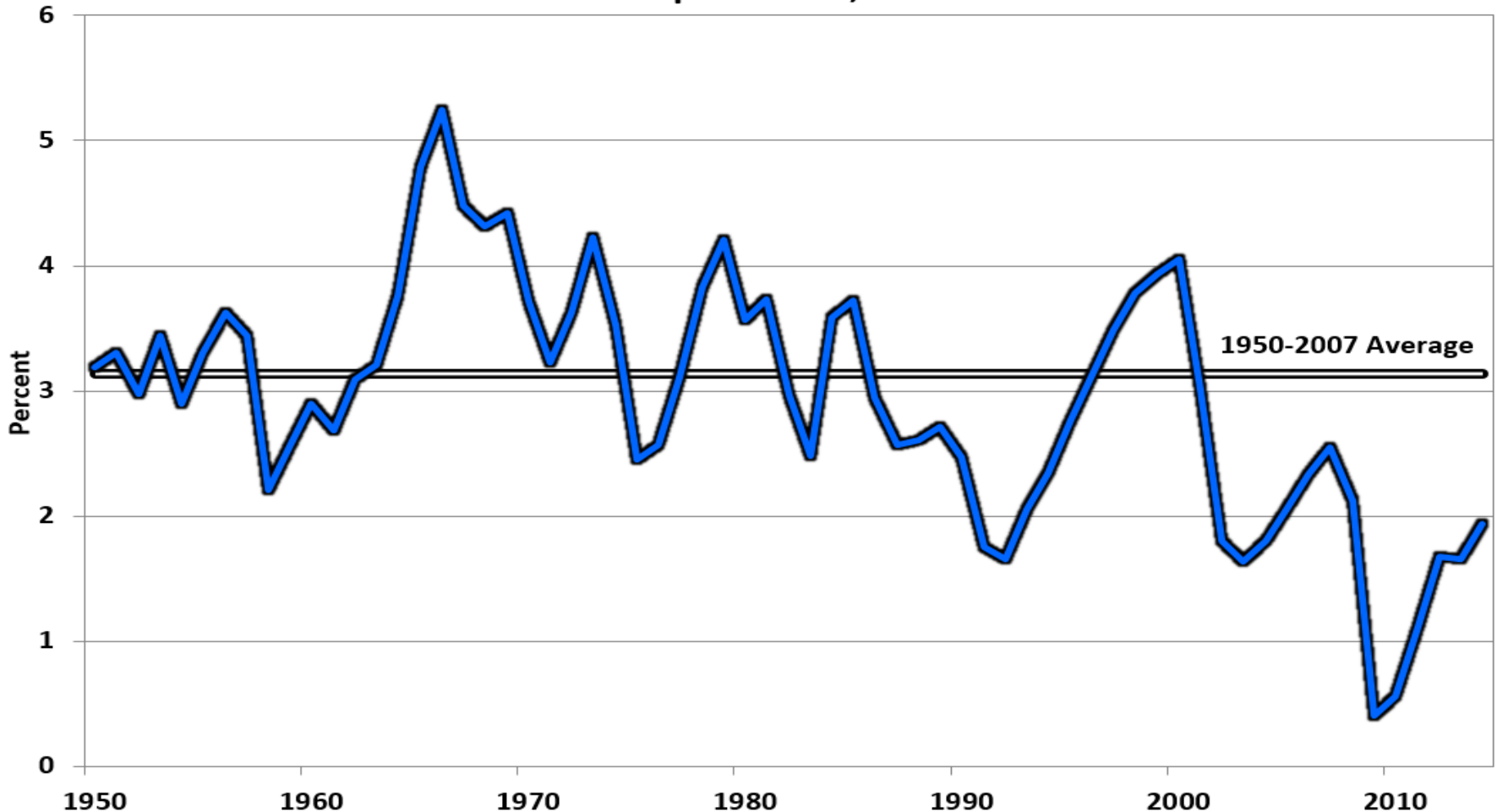
- **Offices use desktop computers with proprietary and web information much as they did 10-15 years ago**
- **Retail stasis. Shelves stocked by humans, meat sliced at service counters, checkout bar-code scanning by humans**
- **Medicine: little change in what nurses and doctors do, one-time transition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

Declining Business “Dynamism” Measured by New Firm Entry



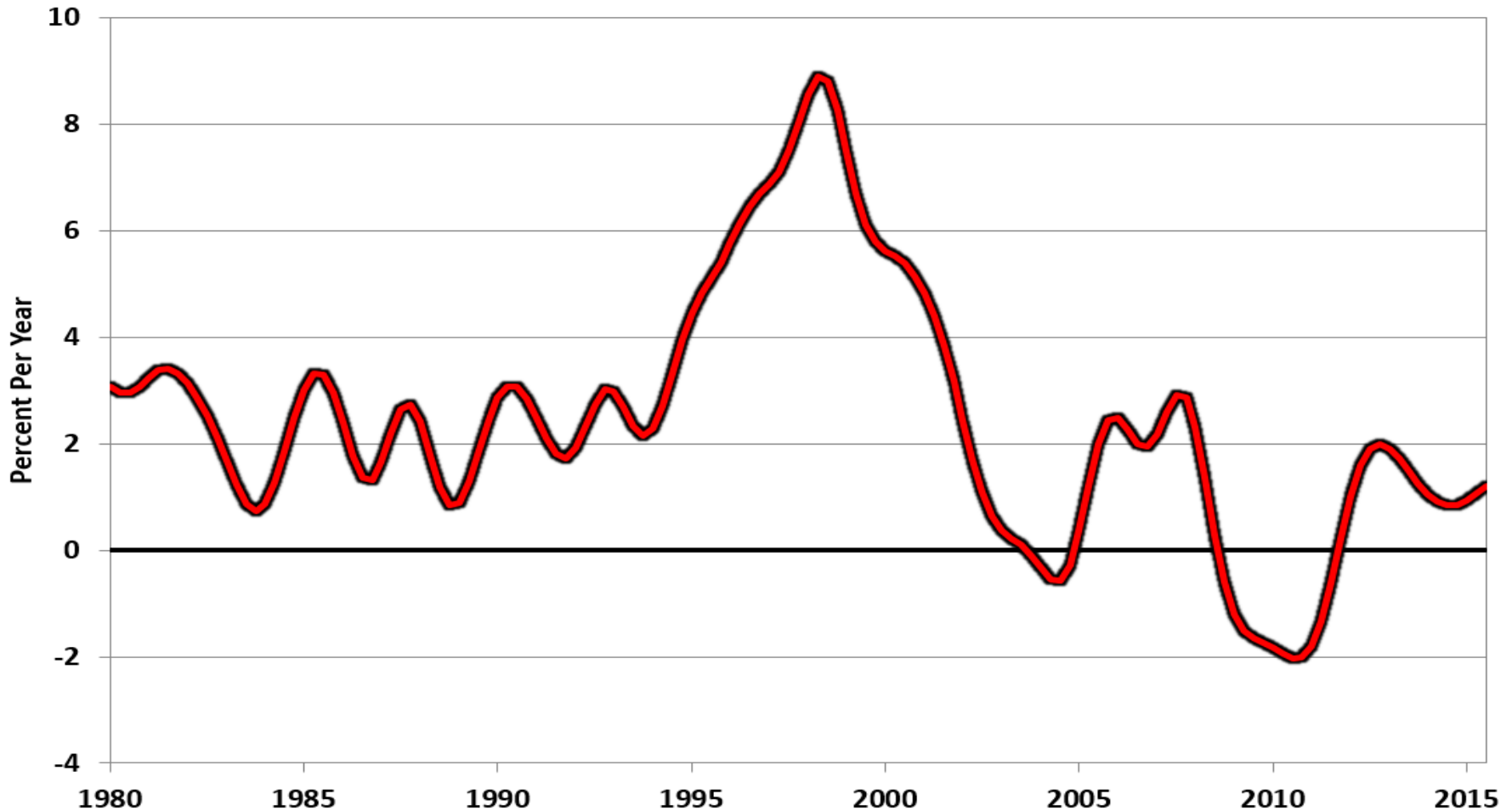
Stagnation Symptom #2: Declining Rate of Net Investment

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 Are Evolutionary Not Revolutionary

- **Artificial Intelligence**
 - Predominant uses of big data are in marketing, zero-sum game
 - Evolutionary change: legal searches, radiology reading, “Robo-advice”
- **Driverless Cars and Trucks**
 - Truck drivers don’t just drive trucks, they unload them and stock the shelves

The Mismeasurement Hypothesis

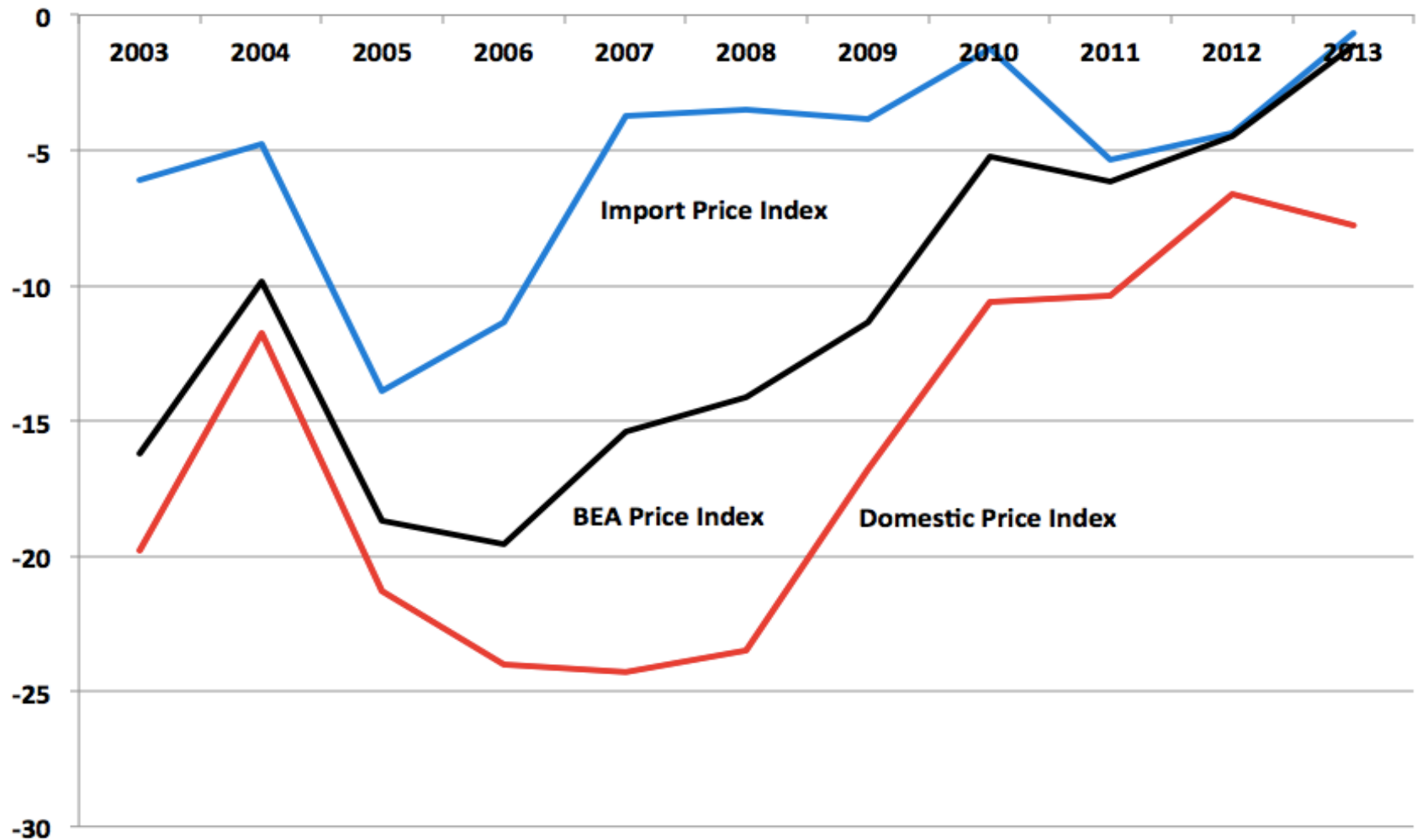
- Jan Hatzius (Goldman Sachs): the entire slowdown is mismeasurement
- The issue is not the understatement of GDP growth, but whether the understatement is larger than in the past
- Growth Rates, Total Economy Productivity:
 - 1994-2004 2.3
 - 2004-2015 1.1
 - 2010-2015 0.5
- For mismeasurement pre/post 2004 to be the explanation, would have to explain $2.3 - 1.1 = 1.2$
- Larger than Boskin Commission for all CPI bias

Computer Prices

- **Matters for GDP deflator and hence real GDP, thus labor productivity**
- **Byrne-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 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

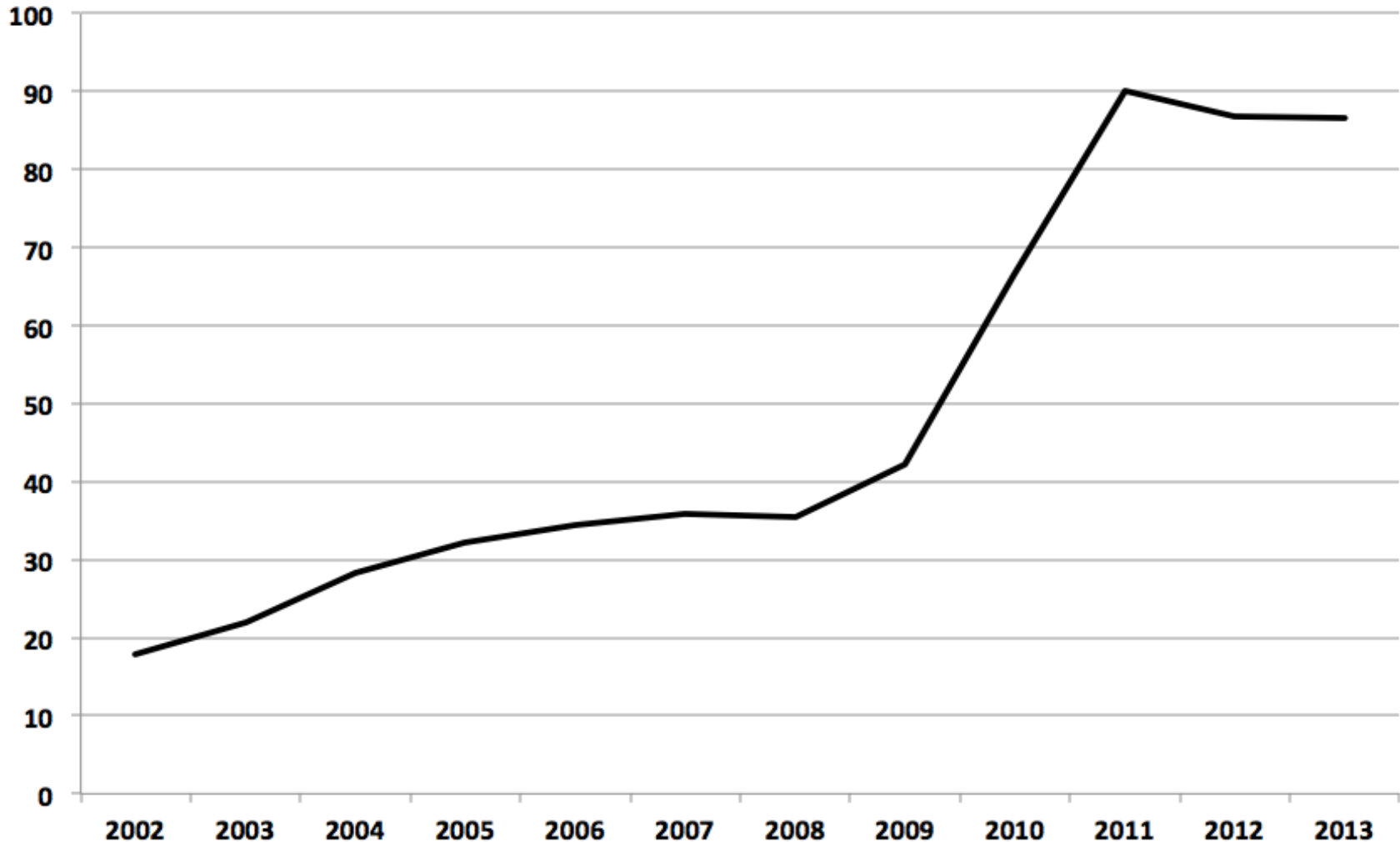


Two Issues with Import Price Index for Computers

- **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%

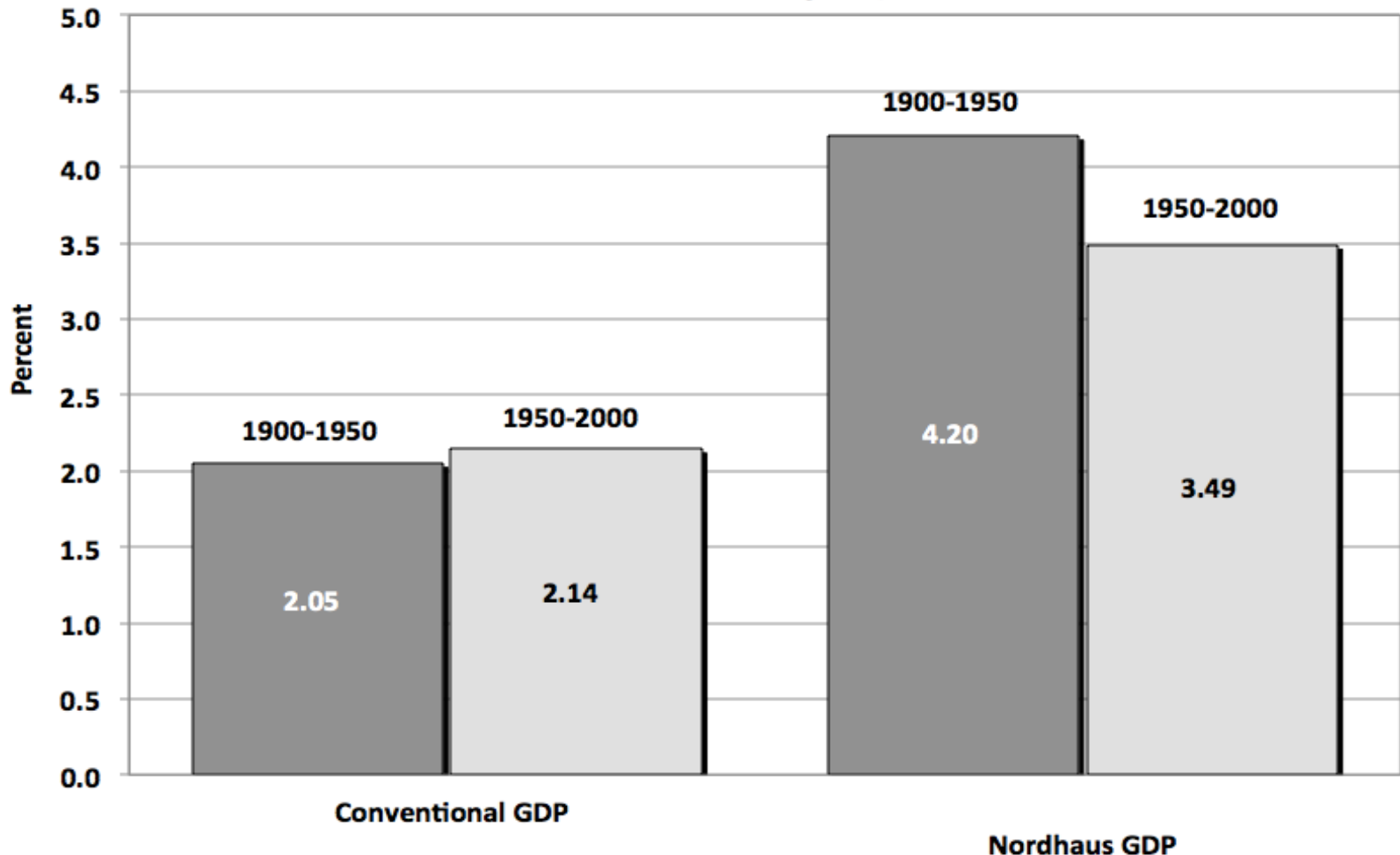
- **To simplify, say it's 100%**
- **That means that computer output is no longer part of GDP**
 - **Any price index bias is irrelevant for GDP**
 - **But raises contribution of capital deepening to productivity growth**
 - **Thus reduces contribution of TFP to productivity growth**
- **Same is true 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
 - 1969-2004. Nordhaus -51%, BEA -19%
 - 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

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

- **Reduction in computer bias 0.3**
- **Opposite direction: free internet services**
 - 0.2? 0.4?
- **The productivity growth slowdown is real**
- **2/3 all TFP growth since 1890 occurred 1920-70**