EC538 Economic Controversies
Long-term Slowdown in US Productivity Growth

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What is Productivity?

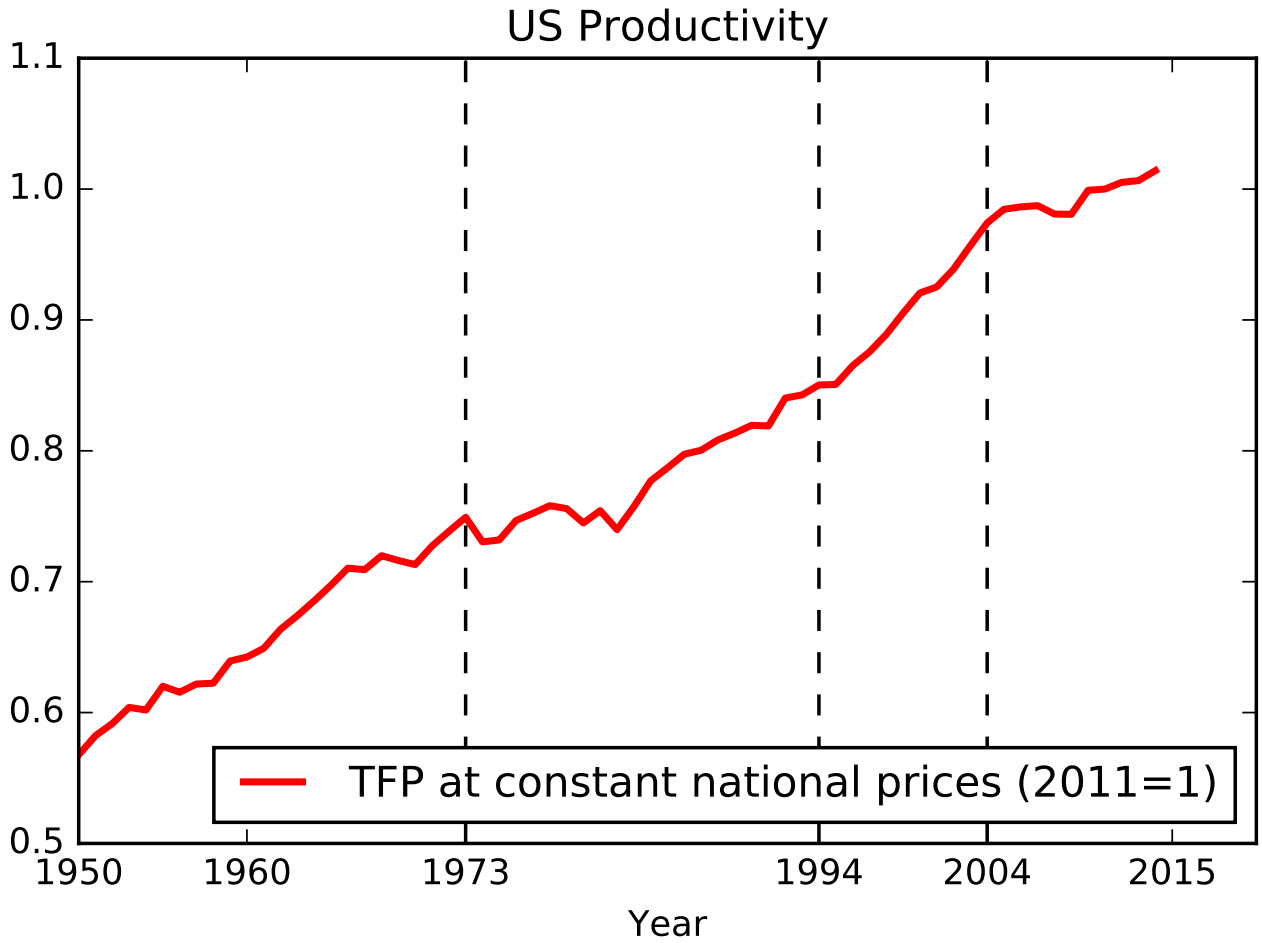
- Productivity = Output / Input
- Output = Nominal GDP / Price Deflator (CPI or PPI)
- Labor productivity = Output / Hours Worked
- Total Factor Productivity (TFP) = Output / Index of all inputs to production

US Labor Productivity Growth

- Labor productivity growth :
  - 1947–1973: 2.7%
  - 1974–1994: 1.5%
  - 1995–2004: 2.8%
  - 2005–2015: 1.3%
- 1.5% drop would lead to 50% income per capita difference in 25 years
- Had the slowdown did not happen, each person would have $9,300 more income

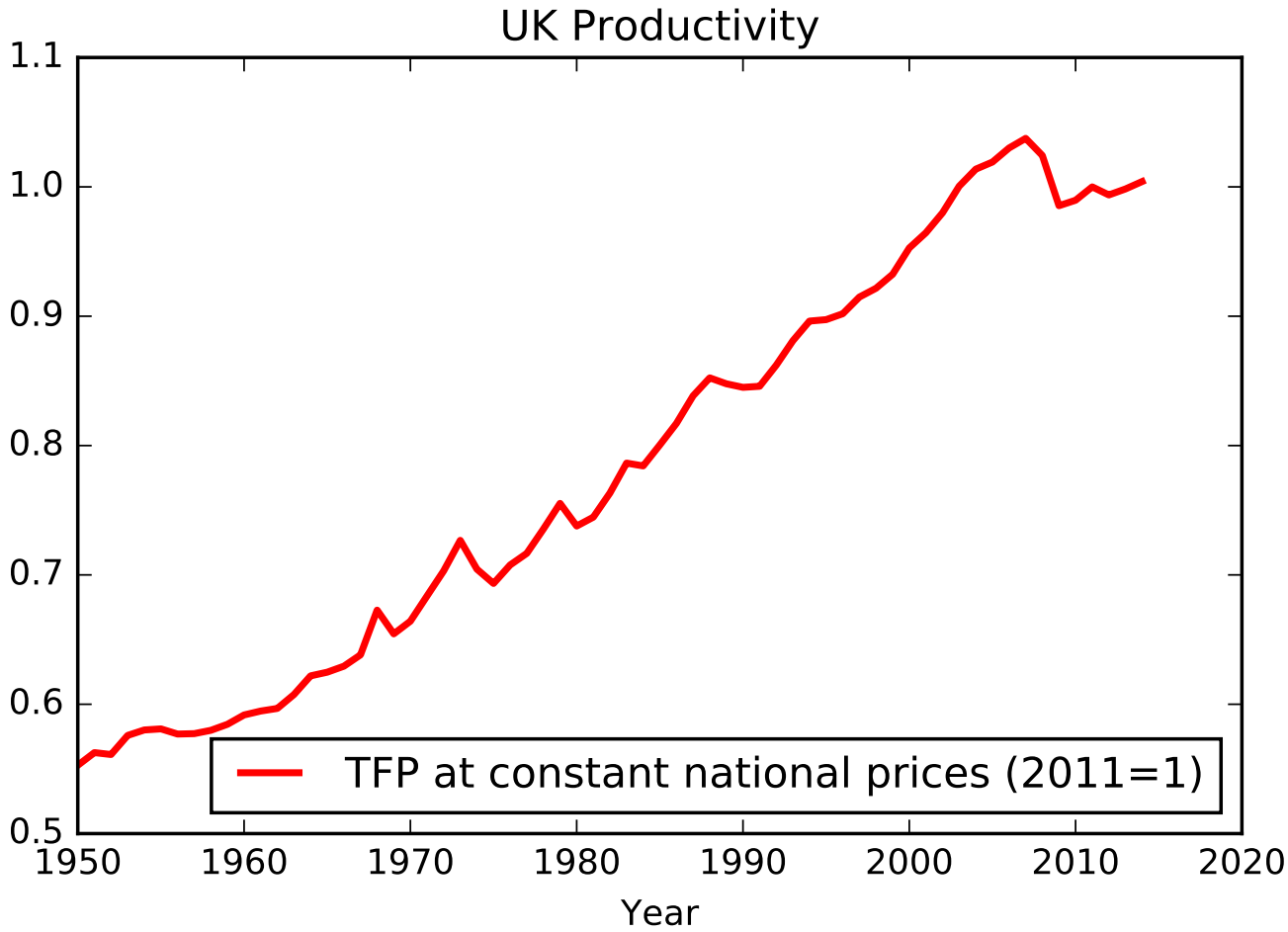
Source: Syverson (2017), US non-farm private business labor productivity data from BLS

Total Factor Productivity, USA



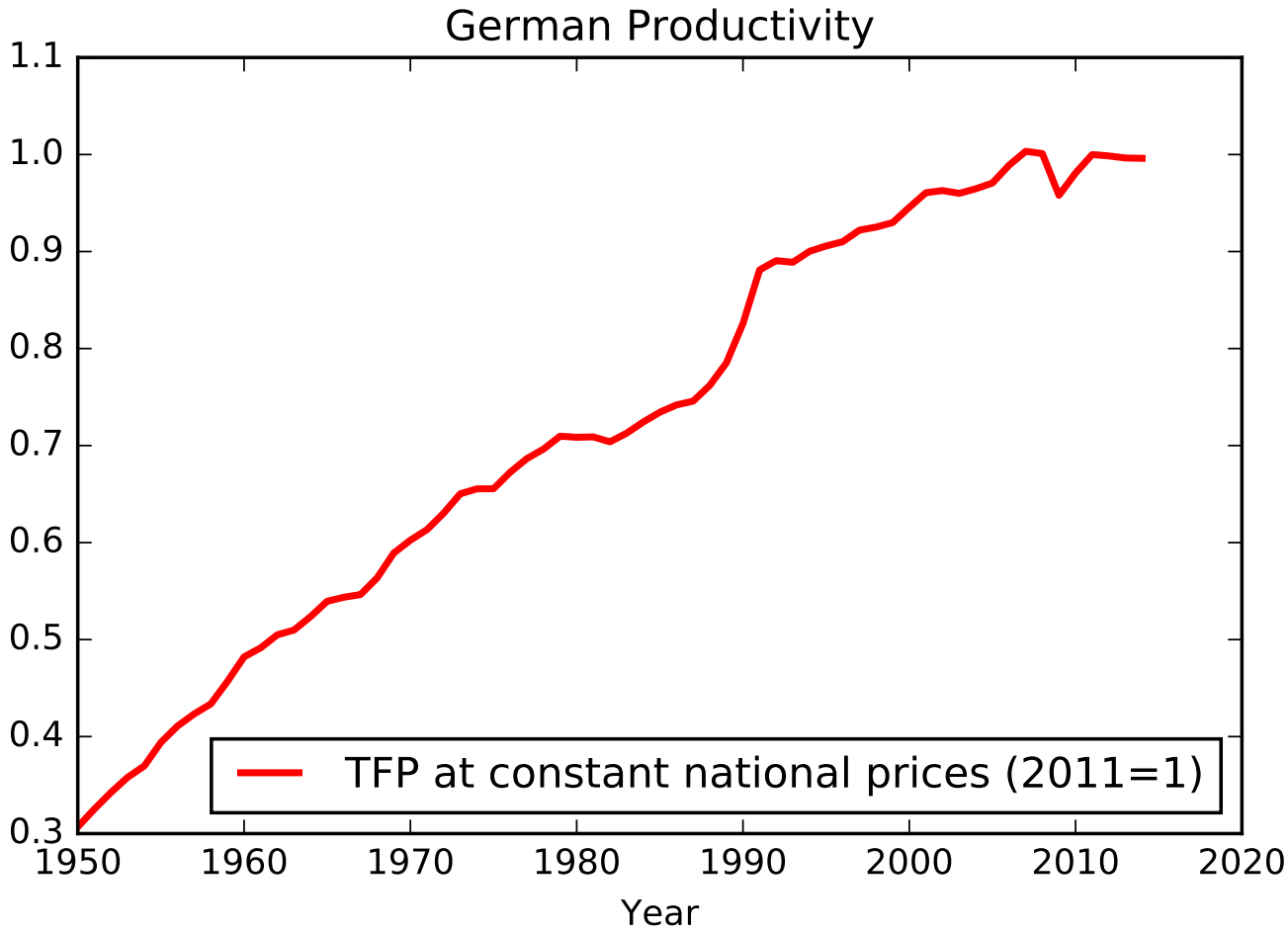
Source: Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer (2015), "The Next Generation of the Penn World Table" American Economic Review, 105(10), 3150-3182

Total Factor Productivity, UK



Source: Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer (2015), "The Next Generation of the Penn World Table" American Economic Review, 105(10), 3150-3182

Total Factor Productivity, Germany



Source: Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer (2015), "The Next Generation of the Penn World Table" American Economic Review, 105(10), 3150-3182

Productivity Growth, Sectoral Decomposition

From 1995–2004 to 2004-2013

- Non-farm business sector: 1.7 percentage points decrease (3.2% to 1.5%, annual)
- Apparel manufacturing: 6 percentage points decrease (1% to -5%)
- Manufacturing of computers and electronics parts: 11 percentage points decrease (15% to 4%)
- Manufacturing of wood products: .4 percentage points increase (2% to 2.4%)
- Radio and TV broadcasting: 5 percentage points increase
- Semiconductors and electronic components: 18 percentage points decrease

Group Question

[Taken from Williamson (2010)]
Using year 1 as the base year, calculate labor productivity growth in the following economy:

- In year 1: 50 apples and 100 oranges are produced, and prices are \$1 and \$.8
- In year 2: 80 apples and 120 oranges are produced, and prices are \$1.25 and \$1.60
- Assume 100 units of labor are used in production in each year.

Group Question, answer

$$rGDP_1 = (\$1 \times 50) + (\$.8 \times 100) = \$130$$

$$\text{Labor Productivity}_1 = 130/100 = 1.3$$

$$rGDP_2 = (\$1 \times 80) + (\$.8 \times 120) = \$176$$

$$\text{Labor Productivity}_2 = 176/100 = 1.76$$

$$\text{Labor Productivity Growth} = (1.76 - 1.3)/1.3 = .35$$

Group Question, answer cont'd

In practice,

- Estimate nominal GDP
- Estimate Consumer Price Index and Producer Price Index
- Deflate components of nominal GDP with related price indexes
- Get an estimate of real GDP and then productivity growth

Group Question, answer cont'd

$$GDP_1 = (\$1 \times 50) + (\$.8 \times 100) = \$130$$

$$GDP_2 = (\$1.25 \times 80) + (\$1.6 \times 120) = \$292$$

$$CPI_1 = \frac{\text{Cost of base year (1) quantities at current prices (1)}}{\text{Cost of base year (1) quantities at base year prices (1)}} \times 100$$

$$CPI_1 = \frac{(\$1 \times 50) + (\$.8 \times 100)}{(\$1 \times 50) + (\$.8 \times 100)} \times 100 = 100$$

$$CPI_2 = \frac{\text{Cost of base year (1) quantities at current prices (2)}}{\text{Cost of base year (1) quantities at base year prices (1)}} \times 100$$

$$CPI_1 = \frac{(\$1.25 \times 50) + (\$1.6 \times 100)}{(\$1 \times 50) + (\$.8 \times 100)} \times 100 = 100 = 171.2$$

Group Question, answer cont'd

$$rGDP_1 = GDP_1 = 130$$

$$rGDP_2 = \frac{GDP_2}{\frac{CPI_2}{CPI_1}} = 292/1.712 = 170.6$$

$$\text{Labor Productivity}_1 = 130/100 = 1.3$$

$$\text{Labor Productivity}_2 = 171/100 = 1.71$$

$$\text{Labor Productivity Growth} = (1.71 - 1.3)/1.3 = .315$$

Group Question

- What might go wrong in estimating nominal GDP?
- What might go wrong in estimating price indexes?

What might go wrong in estimating nominal GDP?

- Digital media provides substantial utility but essentially sold for free
- Offshore profit shifting

Digital Media

Smartphones, social media, downloadable media:

- deliver substantial utility
- not particularly expensive
- relative small portion of the consumption is reflected in GDP

Syverson (2017) argues that diffusion of digital technologies cannot quantitatively account for the productivity slowdown.
We will discuss this point more on the tutorial.

Example

- Consider the iPhone
- Developed and designed in California
- Assembled by an unrelated company in China
- Components from various countries
- Suppose materials and assembly labor cost $250 per phone
- Assume there are no further costs
- Suppose the phone sells at $750
- Gross profit of $500 per phone
- Consider only the iPhones sold outside of the U.S.

Questions

- How much should each iPhone contribute to the U.S. GDP?
- How much of each phone's gross profit is actually included in the U.S. GDP?

How much should each iPhone contribute to the U.S. GDP?

- $250 paid to contract manufacturers and suppliers in Asia is not part of U.S. GDP
- $500 depends on where the value added is created
- Suppose consumers are willing to pay $500 for the design, software, brand name, ...
- If these intangibles are created in California
- Entire $500 should be net export in expenditure-based GDP
- Entire $500 should be increase in Apple's earnings in income-based GDP

How much of each iPhone's gross profit is actually included in the U.S. GDP?

- Gross profit actually included in U.S. GDP may be very small
- If Apple generates intangibles in the U.S. and legally transfers them to foreign affiliate (e.g., one in Ireland)
- Payments to Apple U.S. is part of net export in U.S. GDP
- Payments for the use of intellectual property may be underpriced or not made at all
- Returns to Apple's intangible assets are attributed to an Apple affiliate outside the United States

We will discuss this point more on the tutorial.

What might go wrong in estimating price indexes?

- Quality changes in goods and services
- Introduction of new goods and services

Mismeasurement of Inflation

When comparing one year to the next (Feldstein (2017))

1. The same good or service at the same quality
2. The same good with different quality
3. Wholly new good

Group Question

What are the methods used by statistical agencies to correct for the bias in inflation estimation as a result of quality changes in goods and services and introduction of new goods and services into the market?

Adjusting price indexes for innovation

[Groshen et al. (2017)]

1. quality adjustment from producers
2. outside surveys to measure quality changes
3. hedonic approaches
4. discrete choice models
5. explicit measurement of increased consumer surplus from new goods
6. the special case of disease-based price indexes

Feldstein (2017) argue that these are not enough, especially when measuring output in services and government services. Why?

Table 1

Summary of Methods to Account for New and Improved Goods and Services

Method	*Requires demand estimation*	*Based on characteristics, product, or other*	*Example of studies*	*In production*	*Reason not in production*
Quality adjustment from producer	No	Characteristics	Moulton, LaFleur, and Moses (1998)	Yes; PPI, MXP, CPI[a]	
Input from other surveys	No	Characteristics	Murphy et. al (2008)	Yes; primarily PPI	
Explicit hedonic quality adjustment	No	Characteristics	Fixler, Fortuna, Greenlees, and Lane (1999)	Yes; CPI[b], PPI[c], MXP[c]	
Time dummy hedonic index	No	Characteristics	Byrne, Oliner, and Sichel (2015); Berndt, Griliches, and Rappaport (1995); Griliches (1961)	No	Restrictive assumptions
Imputed hedonic index	No	Characteristics	Erickson and Pakes (2011)	No	Requires larger sample sizes
Discrete choice	Yes	Characteristics	Berry, Levinsohn, and Pakes (1995); Nevo (2001); Petrin (2002)	No	High computational intensity and cost; poor timeliness
Consumer surplus	Yes	Product	Lee and Pitt (1986); Hausman (1997); Broda and Weinstein (2010)	No	Endogeneity problems (under investigation); high cost
Disease-based price indexes	No	Treated disease	Aizcorbe and Nestoriak (2011); Bradley (2013)	Partial; BEA and BLS experimental indexes	Do not yet adjust for differences in outcomes

[a]For example this is done for new vehicles in the CPI and PPI.
[b]See http://www.bls.gov/cpi/cpihqablsbib.pdf for CPI items that are quality adjusted.
[c]PPI and MXP do explicit hedonic quality adjustment for computers.

Source: Groshen et al. (2017)

Creative Destruction

- Aghion, P., Bergeaud, A., Boppart, T., Klenow, P. J., & Li, H. (2017). Missing growth from creative destruction (No. w24023). National Bureau of Economic Research.
- Producer of outgoing item does not produce the incoming item
- Imputation of price changes from a set of surviving products
- Over estimate the inflation
- Missing growth averages around one-third of true total productivity growth

Example

Suppose that

- 80% of products, no innovation, 4% inflation rate
- 10% of products, quality improvement without creative destruction, -6%
- 10% of products, quality improvement due to creative destruction, -6%
- The true inflation rate in this economy is then 2%.
- Suppose further that nominal output grows at 4%,
- True productivity growth is 2% after subtracting the 2% true inflation rate.
- Imputed inflation rate: $8/9 \times 4\% + 1/9 \times -6\% = 2.9\%$
- Growth rate $= 1.1\%$

Group Question

In order the mismeasurement hypothesis to explain productivity slowdown, what are the conditions that need to be satisfied?

Answer

- Mismeasurement should exist
- Mismeasurement should be sizable
- Mismeasurement should increase over time

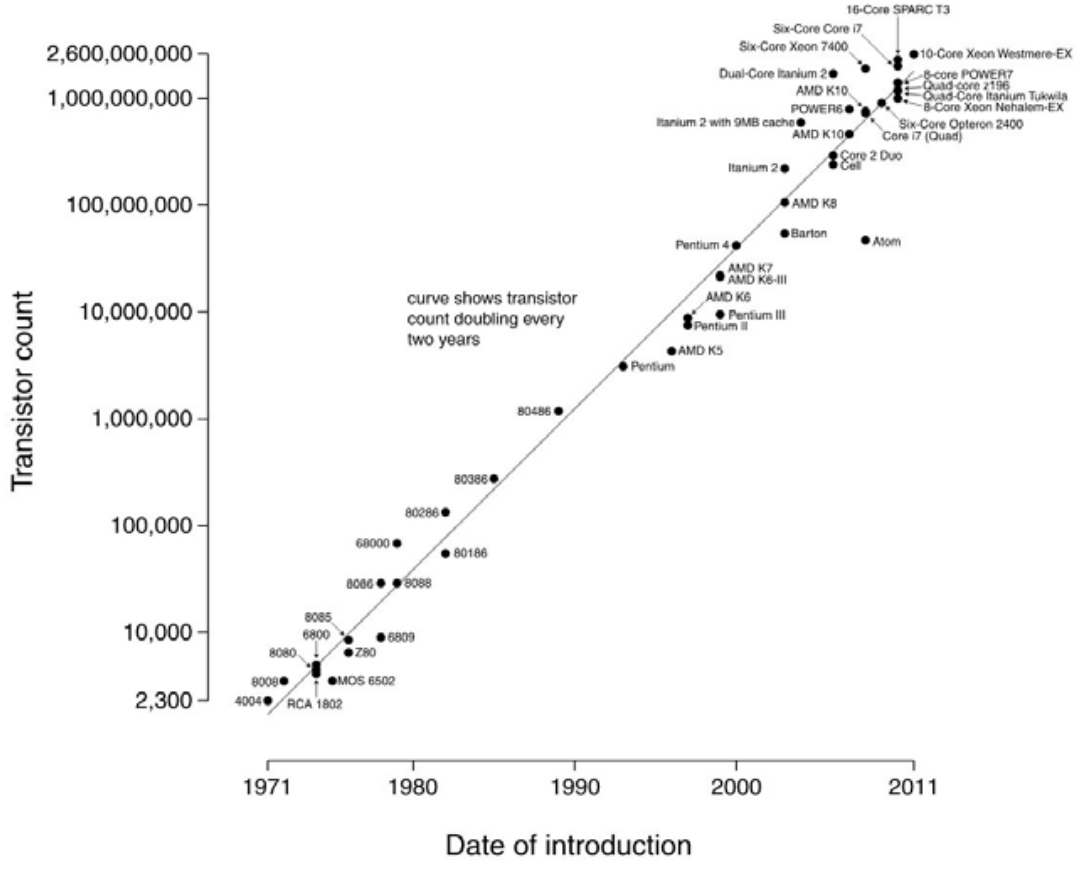
Group Question

What might be the real reasons behind productivity growth slowdown? (i.e., the factors that might actually make the rate of increase in productivity growth to go down)

Productivity Slowdown is Real

- Slowdown is not cyclical (It started before the great recession) [Fernald (2014)]
- Tied to reversal of productivity acceleration and ICT utilization [Byrne, Oliner, and Sichel (2013)]
- 1995–2004 acceleration was one-off aberration [Gordon (2016)]
- Slowdown in business dynamism [Decker, Haltiwanger, Jarmin, and Miranda (2014), Tarullo (2014)]
- Productivity growth from electrification and internal combustion engine came in multiple waves.
- 1995–2004 acceleration need not be one time [Syverson (2003)]
- Ideas are getting harder to find [Bloom, Jones, Van Reenen, and Webb (2017)]

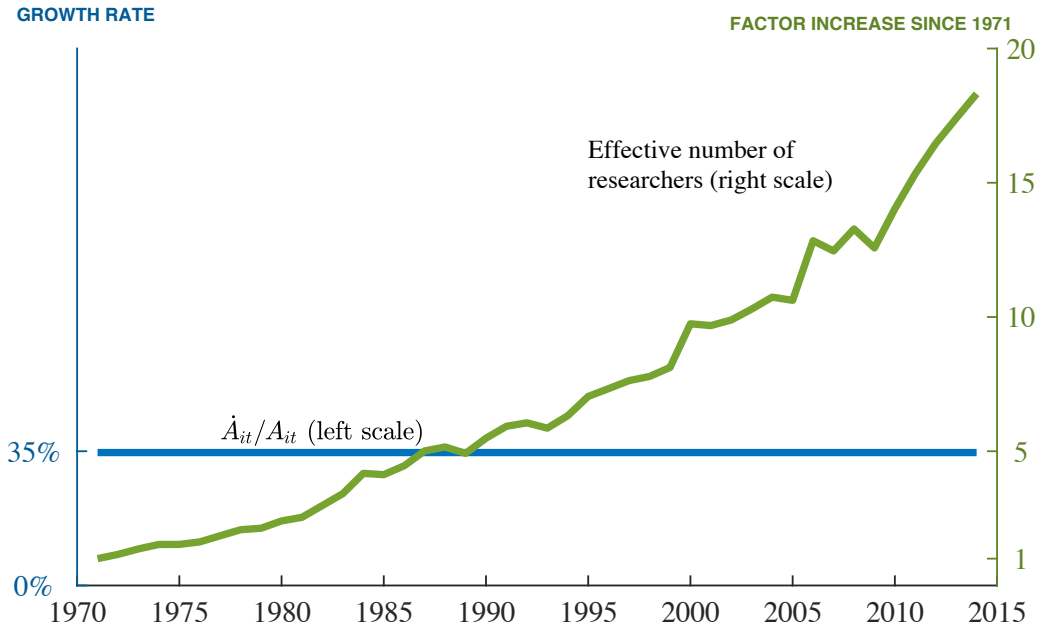
Figure 3: The Steady Exponential Growth of Moore's Law



Source: Wikipedia, https://en.wikipedia.org/wiki/Moores_law.

Source: Bloom, N., Jones, C. I., Van Reenen, J., & Webb, M. (2017). Are ideas getting harder to find? (No. w23782). National Bureau of Economic Research.

Figure 4: Data on Moore's Law



Note: The effective number of researchers is measured by deflating the nominal semiconductor R&D expenditures of key firms by the average wage of high-skilled workers. The R&D data includes research by Intel, Fairchild, National Semiconductor, Texas Instruments, Motorola, and more than two dozen other semiconductor firms and equipment manufacturers; see Table 1 for more details.

Source: Bloom, N., Jones, C. I., Van Reenen, J., & Webb, M. (2017). Are ideas getting harder to find? (No. w23782). National Bureau of Economic Research.

Questions for Tutorial

1. Why does Feldstein (2017) argue that GDP does not properly measure output in services and government services?
2. According to Groshen et al. (2017), what are the criteria that need to be satisfied in order to a methodological improvement to be implemented?
3. How do Guvenen et al. (2017) calculate the missing GDP resulting from profit shifting of multinational companies?
4. How large is the amount of profit shifting? Does it support the mismeasurement hypothesis?
5. How does Syverson (2017) show that advent and diffusion of digital technologies cannot account for the productivity slowdown?
6. Besides Moore's law, what other examples Bloom et al. (2017) provide to show that ideas are getting harder to find?

Thank you!