The Romer Model: Policy Implications

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Econ520

November 22, 2021

Policies have level effects

What are the effects of government policies?

We may expect policies to affect saving (s_K), R&D (s_A), or population growth (n).

Consider the case of $\phi < 1$, where growth is

$$g(A) = \frac{\lambda \ n}{1-\phi} \tag{1}$$

Main result: Policies that affect only saving or investment in R&D (s_A) do not affect long-run growth.

Note: For policies that do not affect R&D the model behaves exactly like the Solow model.

R&D Subsidies

Consider a permanent increase in s_A.

We must consider two equations:

$$g(A) = B\ (s_A L)^{\lambda}\ A^{\phi-1} \tag{2}$$

$$\dot{K} = s_K\ Y - d\ K \tag{3}$$

Note: Behavior of A is independent of K and Y.

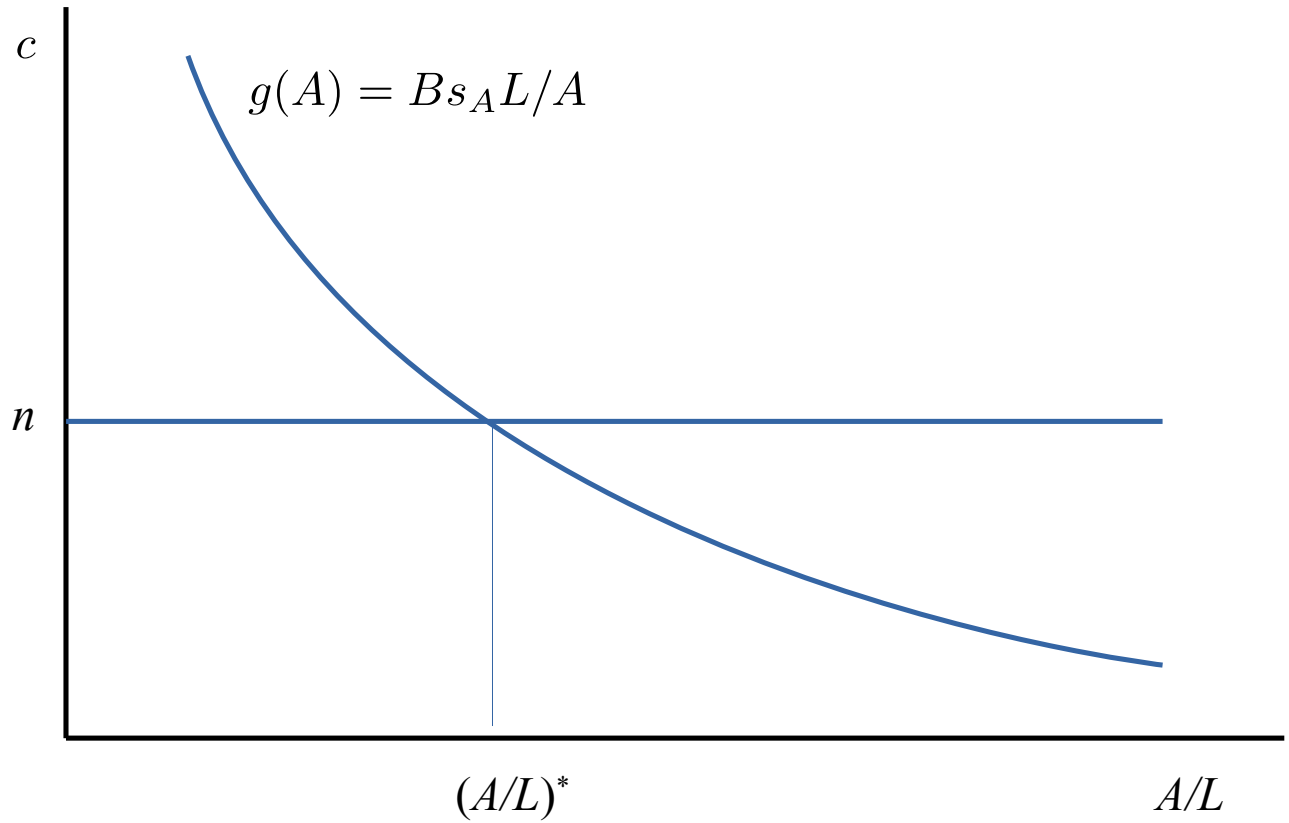
Simplify by assuming $\lambda = 1$ and $\phi = 0$ so that

$$g(A) = B\ s_A\ L\ /\ A \tag{4}$$

Balanced growth rate:

$$g(A) = n$$

R&D Subsidies



R&D Subsidies

On a **BGP**, (4) determines A/L:

$$g(A) = n = Bs_A L/A \tag{5}$$

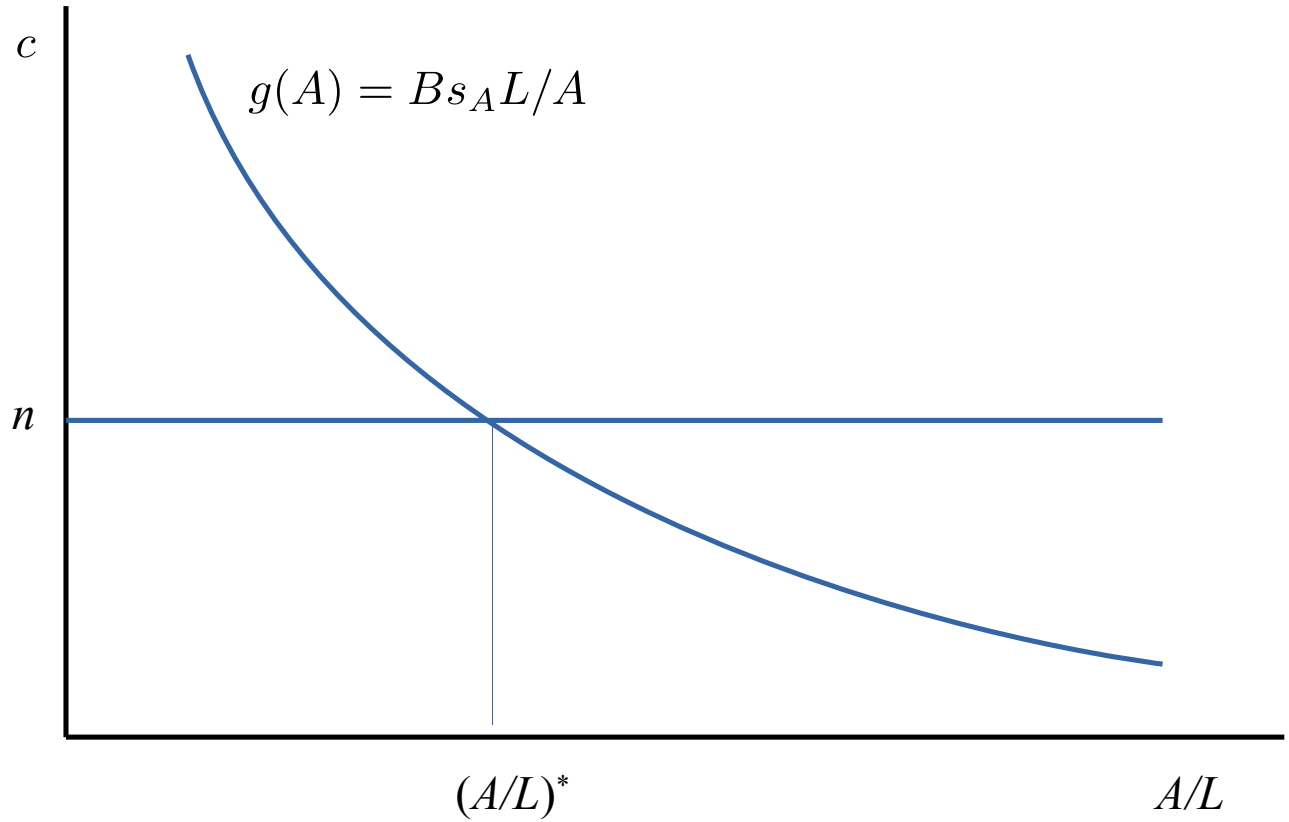
implies

$$(A/L)^* = \frac{B\ s_A}{n} \tag{6}$$

Transition:

- As long as L/A is above BGP, $g(A) > n$ is above BGP.
- Therefore, $g(A)$ declines over time until it reaches n.
- The BGP is stable.

Transition path after an increase in s_A



Time path of the growth rate of ideas

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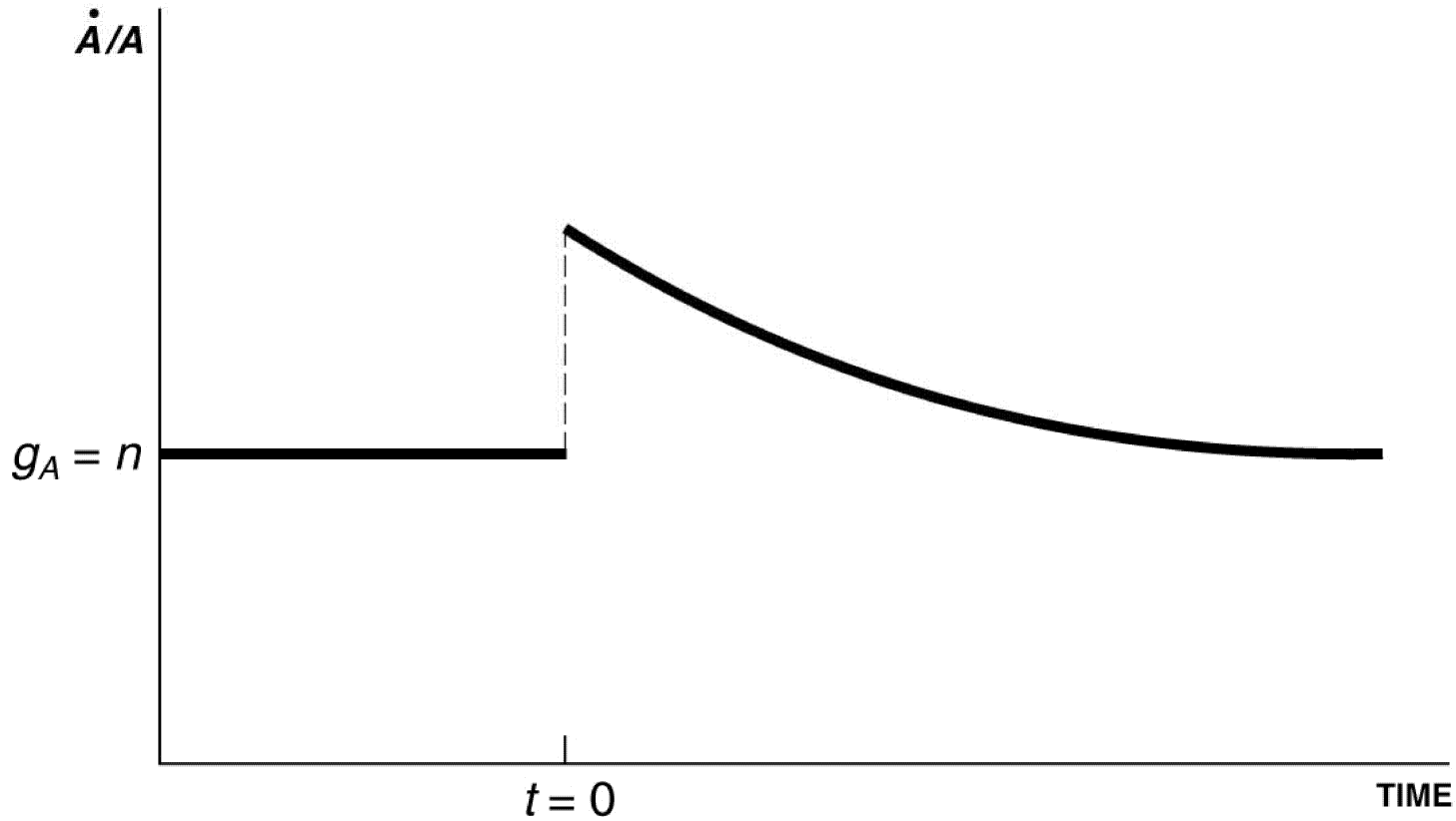


5.2 $\dot{A}/A$ OVER TIME

Economic Growth,

A period of faster innovation builds up more ideas.

Time path of A

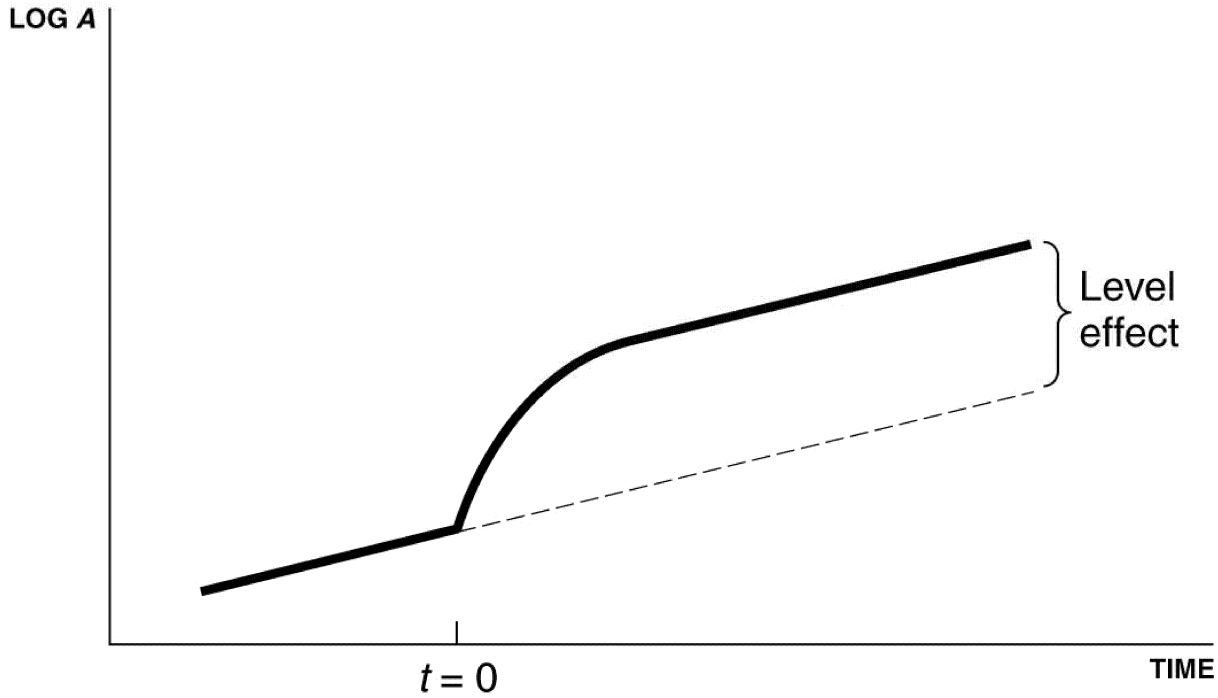


FIGURE 5.3 **THE LEVEL OF TECHNOLOGY OVER TIME**

Economic Growth,

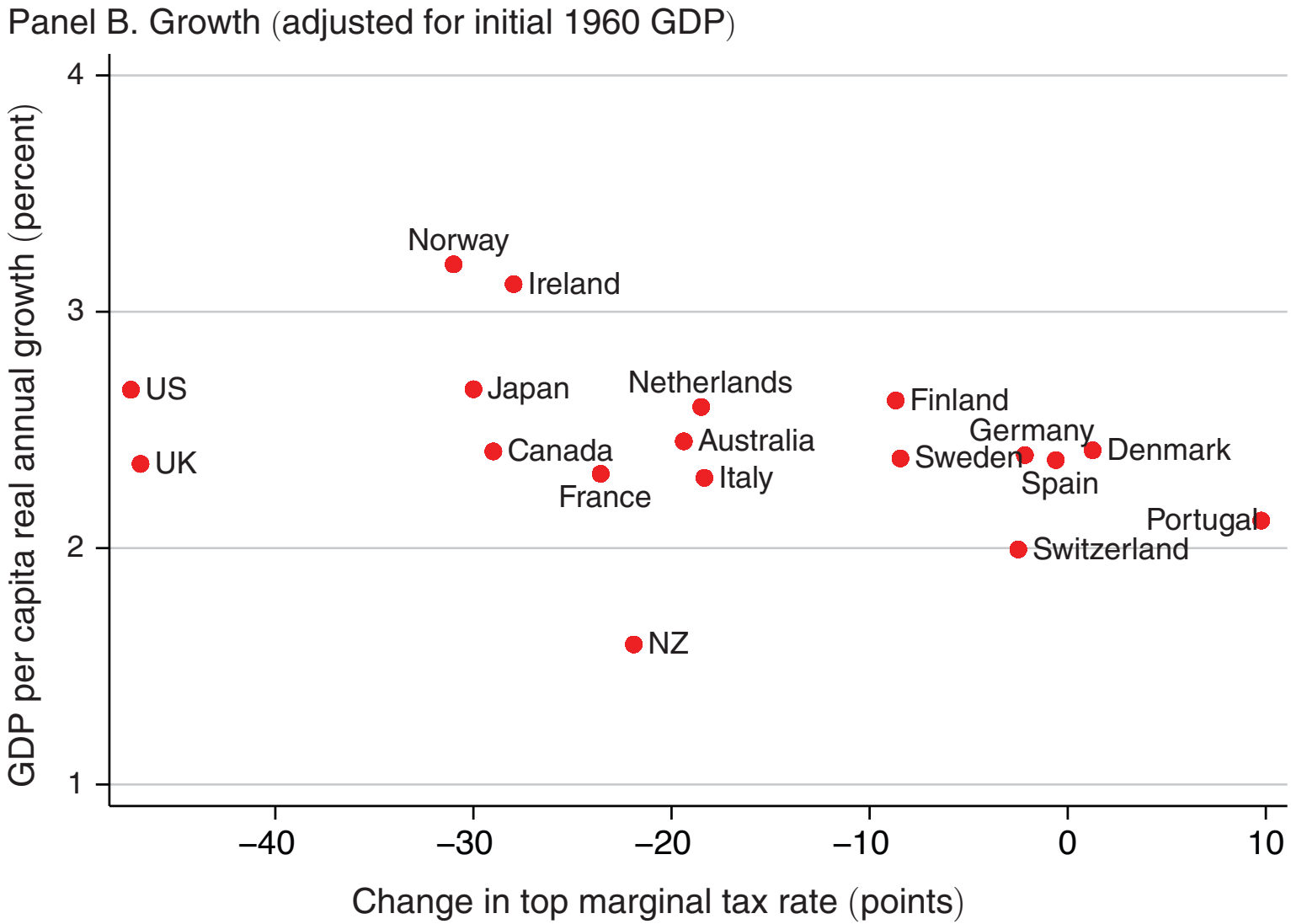
Eventually growth levels off, but the higher level of A remains forever.

Policy implications

- Patent protection, R&D subsidies, and other policies affect s_A.
- These policies can raise the growth rate of output, although not in the long run.
- Policies do affect long-run levels of Y/L.

How could the hypothesis that taxes do not change long-run growth be tested?

Empirical evidence



Source: Piketty et al. (2014)

Is Growth Sustainable?

Outlook for U.S. growth

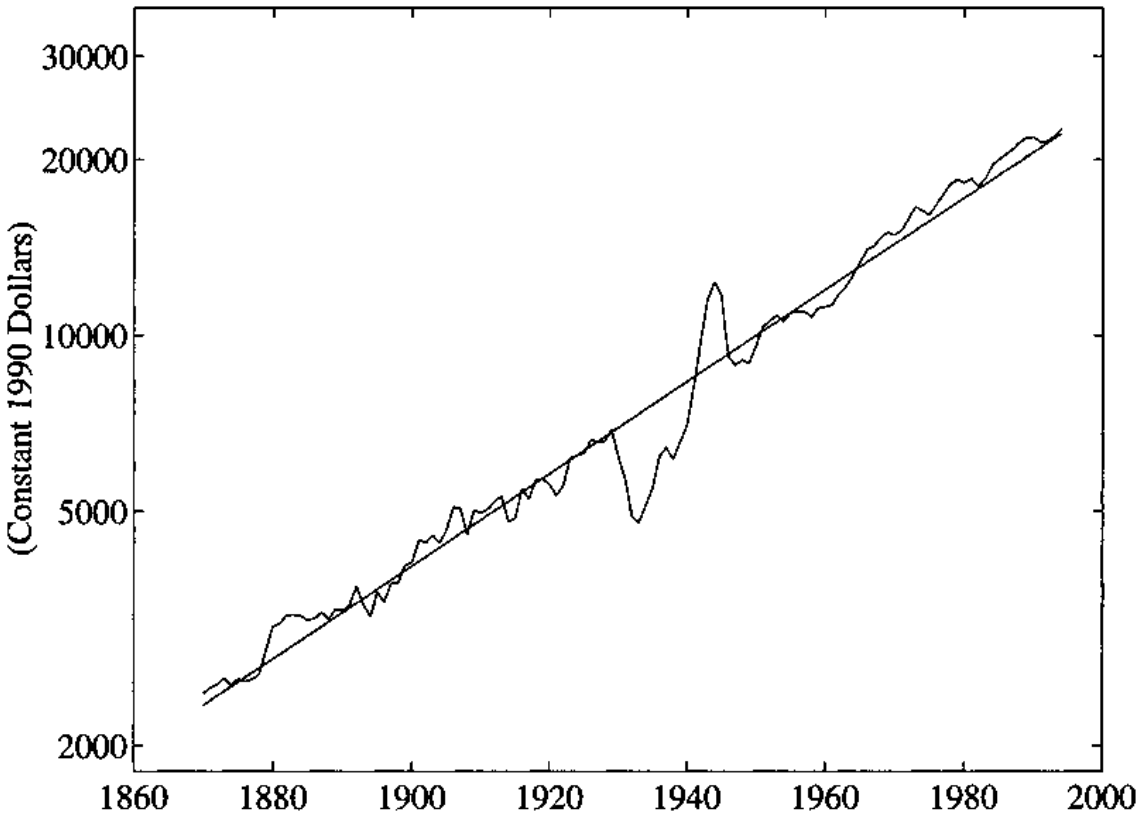


FIGURE 1. U.S. GDP PER CAPITA, LOG SCALE

Source: Jones (2002)

U.S. growth has been constant for a long time.

But are we on a balanced growth path?

Will growth level off?

The basic idea of Jones (2002):

- Over the past 100 years, inputs that improve productivity have been rising: years of schooling; R&D spending / output.
- Eventually, these must level off.
- Then output growth must slow down.
- By how much?

Inputs that increase productivity are rising

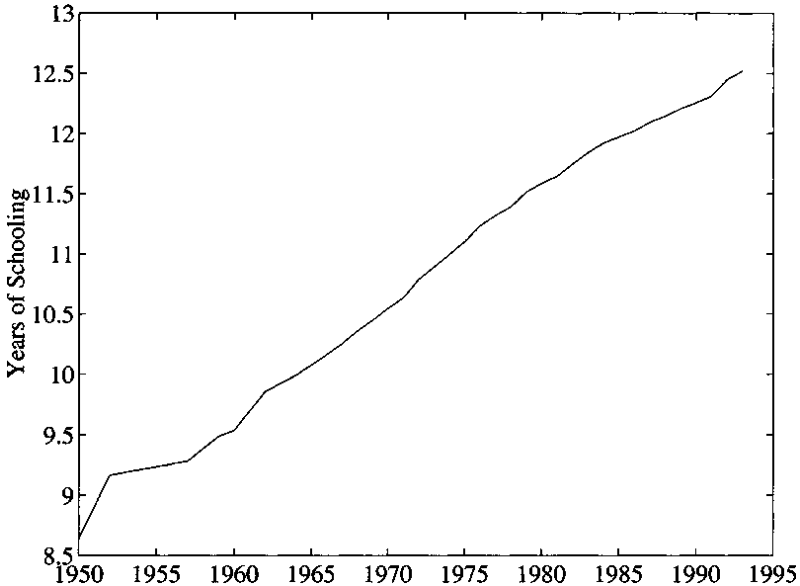


FIGURE 3. AVERAGE U.S. EDUCATIONAL ATTAINMENT, PERSONS AGED 25 AND OVER

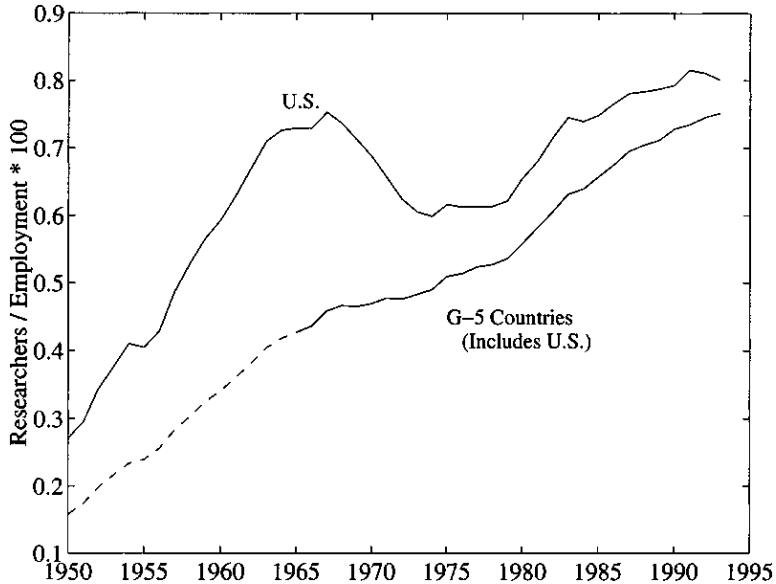


FIGURE 4. RESEARCH INTENSITY IN THE G-5 COUNTRIES

What happens when these inputs stop growing?

A Model

Extend the Romer model to incorporate:

1. Human capital in the production of output.
2. Human capital in R&D.

Output production:

$$Y_t = A_t^{\sigma} K_t^{\alpha} \left(h_t L_{Yt}\right)^{1-\alpha} \tag{7}$$

Then

$$y_t = Y_t / L_t = \left(K_t / Y_t\right)^{\alpha/(1-\alpha)} l_{Yt} h_t A_t^{\sigma/(1-\alpha)} \tag{8}$$

Output growth

Along the transition:

$$g(y) = \frac{\alpha}{1-\alpha} g(k/y) + g(l_Y) + g(h) + \frac{\sigma}{1-\alpha} g(A) \tag{9}$$

Balanced growth rate:

K/Y and l_y must be constant over time

$$g(y) = g(h) + \frac{\sigma}{1-\alpha} g(A) \tag{10}$$

In addition: $g(A)$ will slow down when R&D inputs stop growing.

We expect the balanced growth rate to be lower even than past TFP growth.

R&D sector

$$\dot{A}_t = B\left(l_{At} h_t L_t\right)^{\lambda} A_t^{\phi} \tag{11}$$

so that

$$g\left(A\right) = \frac{\left(h_t l_{At} L_t\right)^{\lambda}}{A_t^{1-\phi}} \tag{12}$$

Balanced growth:

$$g\left(A\right) = \frac{\lambda\left(g\left(h\right) + n\right)}{1-\phi} \tag{13}$$

Assume long-run $g\left(h\right) = 0$ because schooling levels off (strong assumption).

Then (just like in our textbook model):

$$g\left(A\right) = \frac{\lambda}{1-\phi} n \tag{14}$$

BGP output growth

$$g(y) = \frac{\sigma}{1-\alpha} g(A) = \underbrace{\frac{\sigma}{1-\alpha}\frac{\lambda}{1-\phi}}_{\gamma} n \tag{15}$$

Normalize $\sigma = 1-\alpha$. Then $\gamma = \lambda/(1-\phi)$.

Key point

Transitional growth has several sources:

- $g(h)$,
- growth of A in excess of γn, and
- balanced A growth of γn.

Only the γn part is sustainable!

Quantifying the slowdown

We observe: $g(y) = 2\%$ per year

Balanced growth: γn where $n = 1.2\%$ per year.

So the value of γ determines the slowdown.

How big is γ?

Key idea (roughly):

$$g(A) = \frac{(h_t l_{At} L_t)^{\lambda}}{A_t^{1-\phi}} \tag{16}$$

- We observe $g(A), h, L_A$.
- If $g(A)$ was constant over time (roughly true), the we can estimate $\gamma = \lambda/(1-\phi)$.

Result: $\gamma \approx 1/3$.

Key implication

Only 1/3 of past TFP growth is sustainable once transitory increases of h and l_A comes to an end.

Growth accounting implications

Post-war average growth $g(y) = 0.02$

$n = 0.012$

Balanced growth $= \gamma n = (1/3) \times 1.2\% = 0.4\%$

Transition dynamics

We can simulate the model path to find out how rapidly growth slows down.

Result: Growth slows by half (relative to γn) every 40 years.

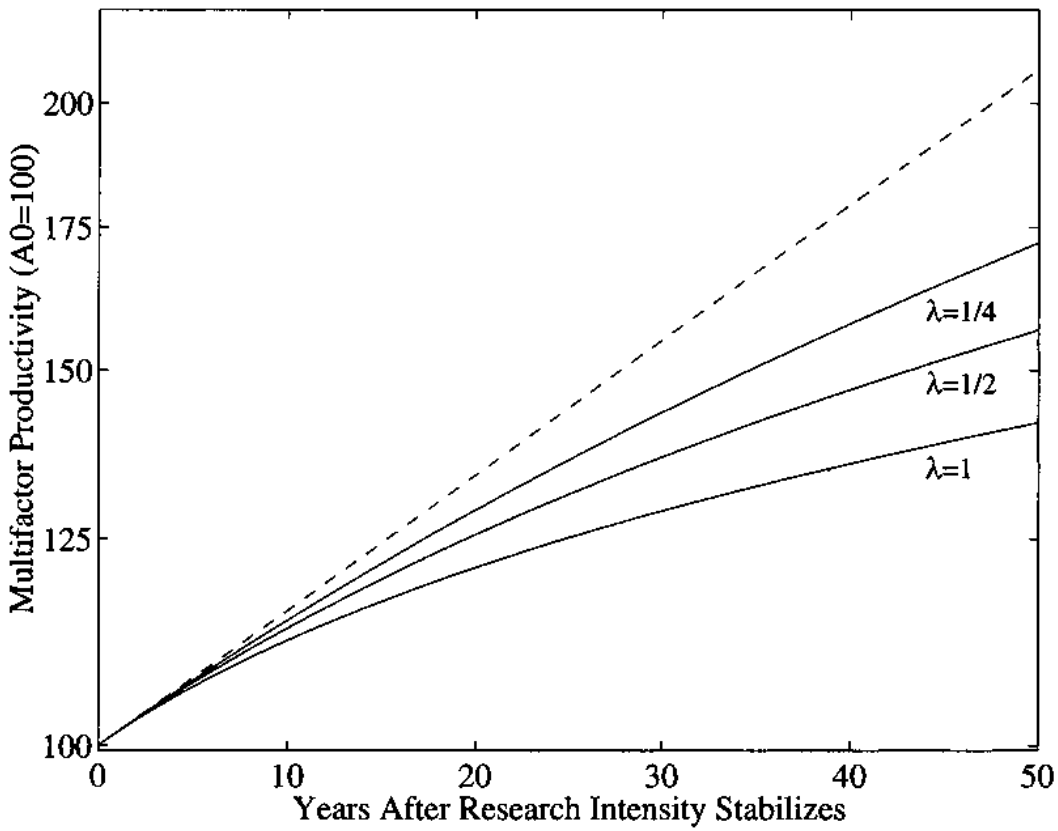


FIGURE 5. THE TRANSITION OF MULTIFACTOR PRODUCTIVITY TO STEADY STATE

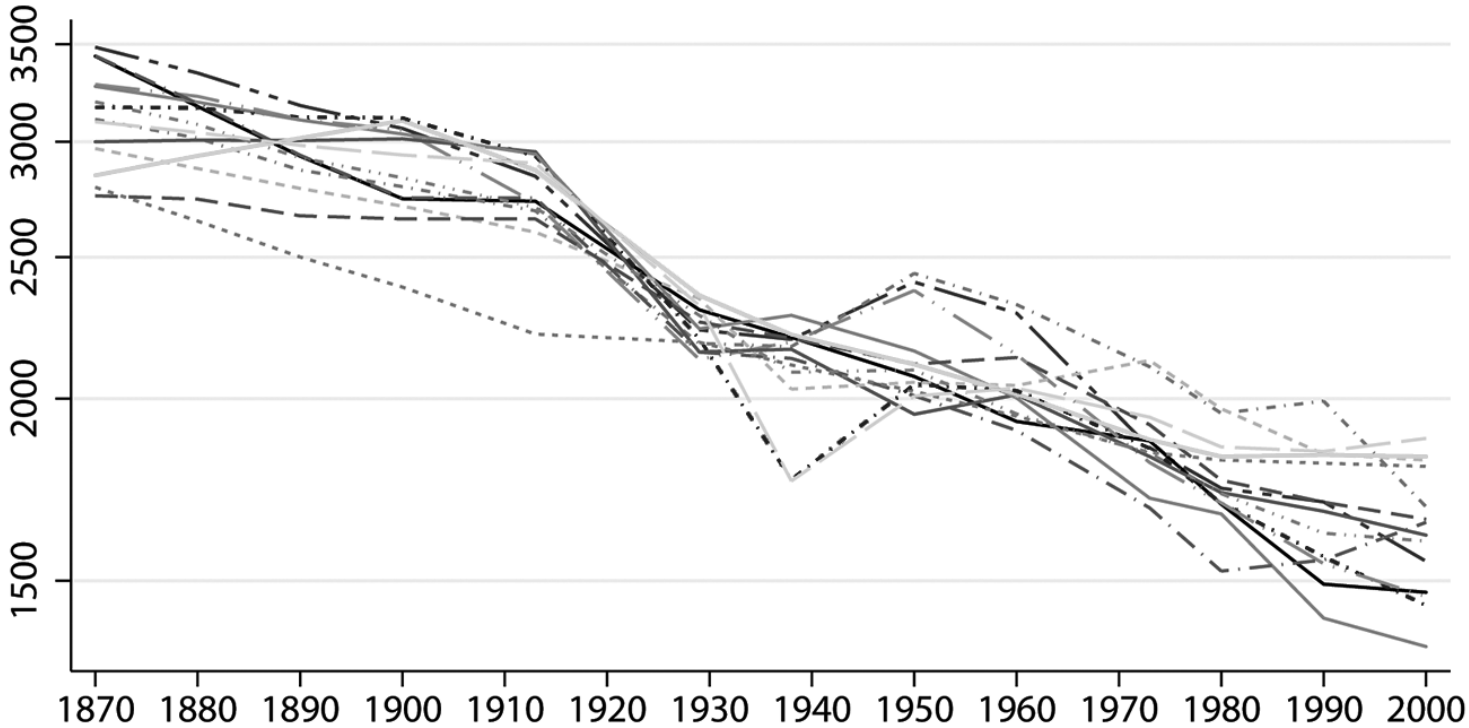
Discussion

Thoughts?

Does Growth Cost Jobs?

How do we think about this question?

Falling hours worked

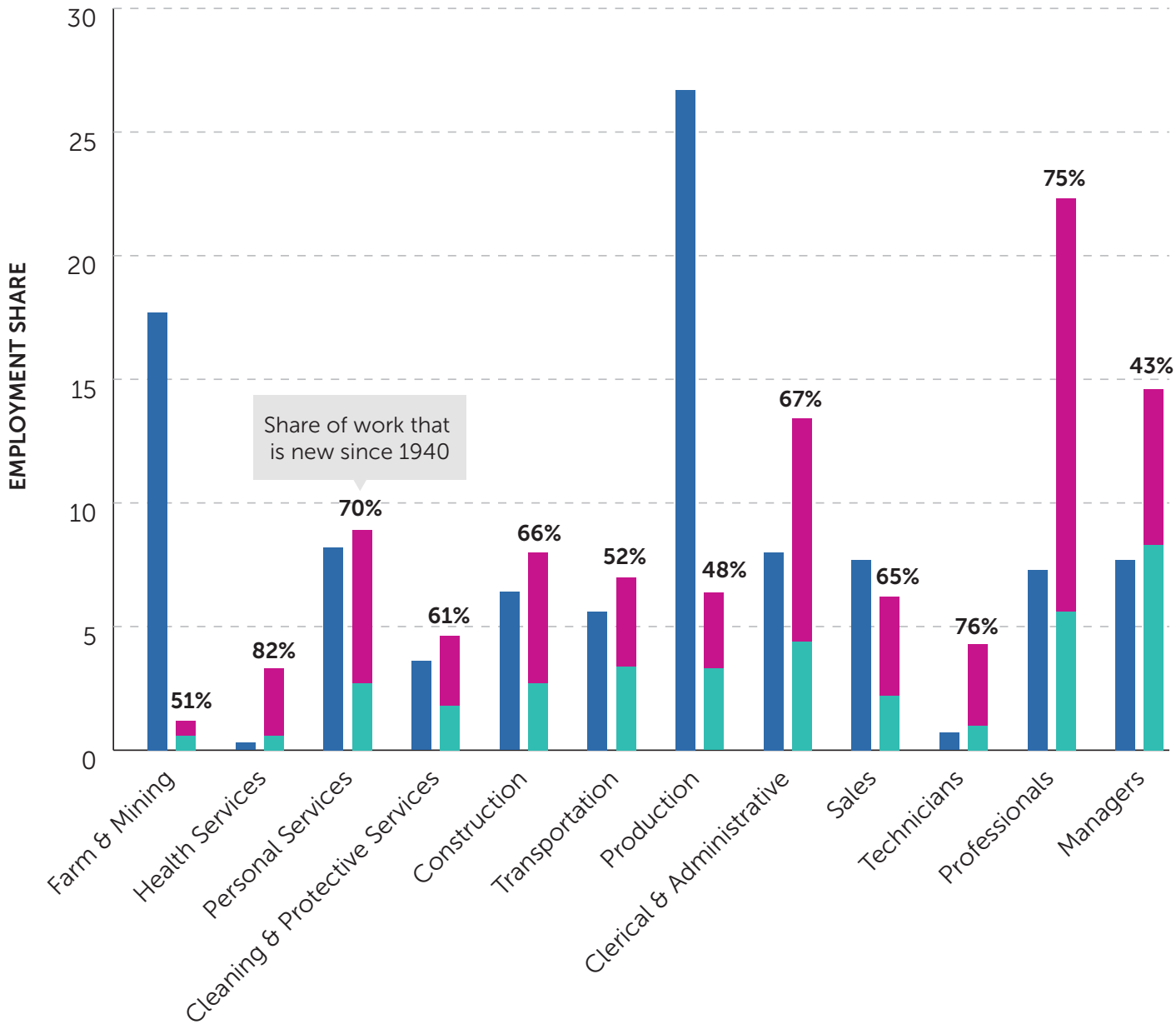


Source: Boppart and Krusell (2019). See also the VoxEU summary.

Is this evidence of job loss?

Technologies create new jobs

Figure 2. More Than 60% of Jobs Done in 2018 Had Not Yet Been "Invented" in 1940



Middle income jobs are automated

Figure 6. Employment Growth Has Polarized Between High- and Low-Paid Occupations

CHANGES IN OCCUPATIONAL EMPLOYMENT SHARES AMONG WORKING-AGE ADULTS, 1980–2015

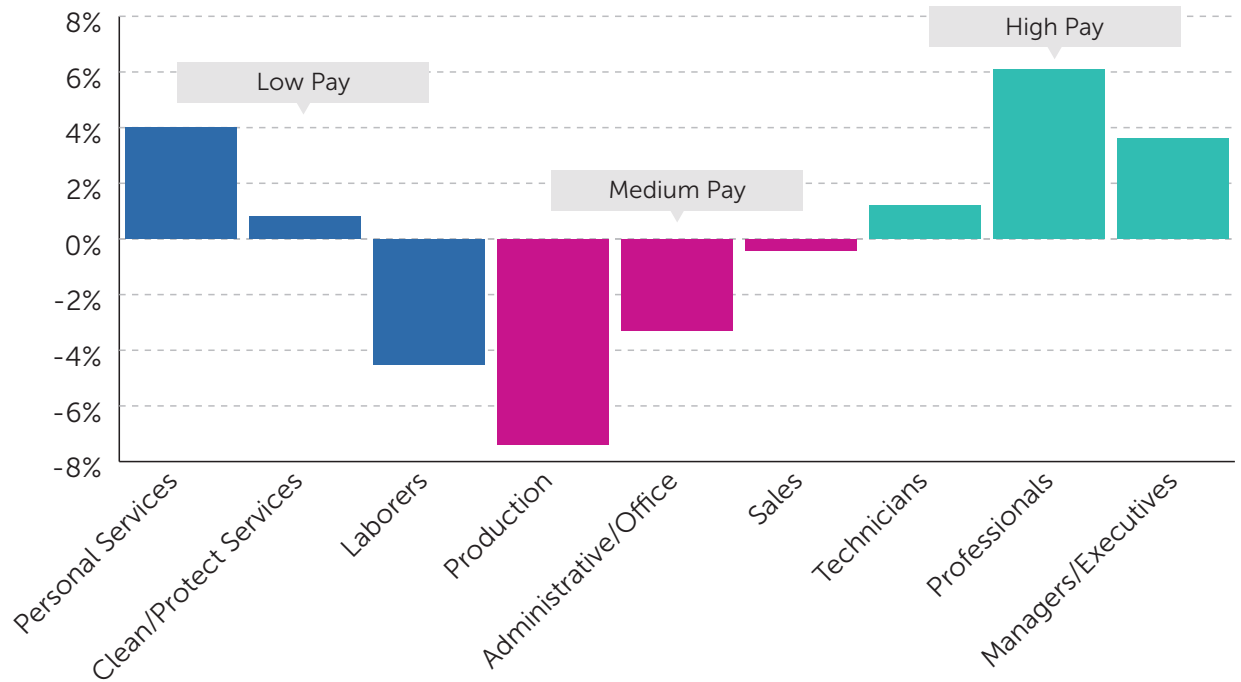
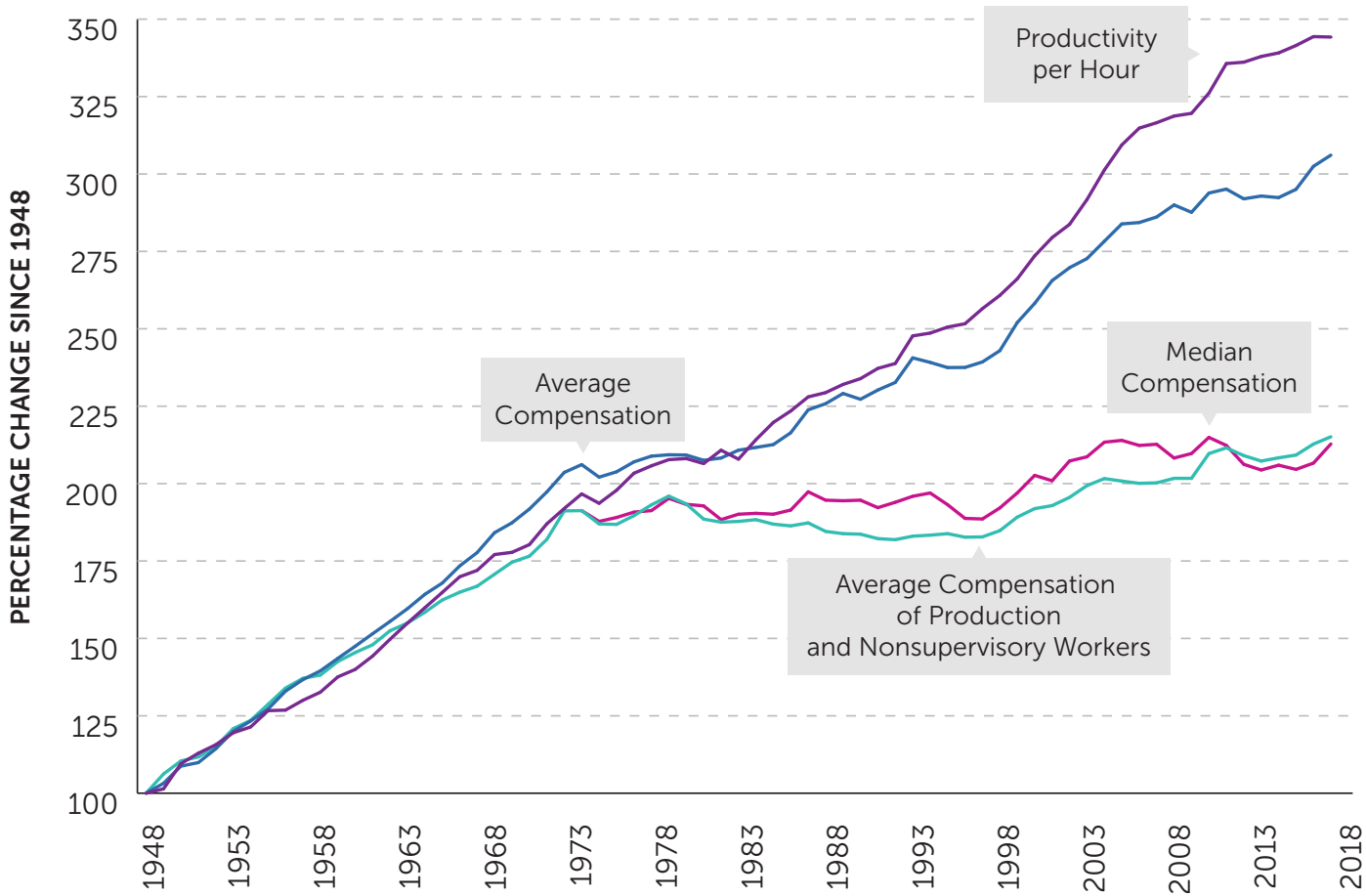


Figure is constructed using U.S. Census of Population data for 1980, 1990, and 2000, and pooled American Community Survey (ACS) data for years 2014 through 2016, sourced from IPUMS (Ruggles et al., 2018). Sample includes working-age adults ages 16 – 64 excluding those in the military. Occupational classifications are harmonized across decades using the classification scheme developed by Dorn (2009).

Source: Autor (2020)

Labor income lags output growth

Figure 4. Productivity and Compensation Growth in the United States, 1948–2016



Source: Autor (2020)

Does growth cost jobs?

What is the overall answer?

- We do not see large numbers of working age persons unable to find jobs.
- But we see displacement of middle skill jobs.

Future automation could render many workers obsolete.

Autor (2020): "No economic law dictates that the creation of new work must equal or exceed the elimination of old work. Still, history shows that they tend to evolve together."

Summary

- Innovations are produced just like regular goods, but they are non-rival.
- Therefore, we have scale effects: larger markets support more rapid innovation.
- The growth rate of Y/L is proportional to the population growth rate.
- A one-time increase in R&D effort (higher L_A) raises the rate of innovation permanently.
  - But this is not enough to sustain higher long-run growth.
- Policies only have level effects.

Final Example

What is the effect of a permanent increase in

1. research productivity (easy)
2. population (holding k fixed or not)
3. population growth (Europe)

Reading

- Jones (2013b), ch. 5.
- The section on the outlook for US growth is based on Jones (2002).

Optional:

- Romer (2011), ch. 3.1-3.4
- Jones (2013a), ch. 6

Advanced Reading

- Jones (2005) talks in some detail about the economics of ideas.
- Lucas (2009) and McGrattan and Prescott (2009) on openness and growth

References I

Autor, D. (2020): "The Work of the Future," Tech. rep., MIT Work of the Future Task Force.

Boppart, T. and P. Krusell (2019): "Labor Supply in the Past, Present, and Future: A Balanced-Growth Perspective," *Journal of Political Economy*, 128, 118–157, publisher: The University of Chicago Press.

Jones, C. I. (2002): "Sources of US economic growth in a world of ideas," *The American Economic Review*, 92, 220–239.

——— (2005): "Growth and ideas," *Handbook of economic growth*, 1, 1063–1111.

——— (2013a): *Macroeconomics*, W W Norton, 3rd ed.

Jones, Charles; Vollrath, D. (2013b): *Introduction To Economic Growth*, W W Norton, 3rd ed.

References II

Lucas, R. E. (2009): "Trade and the Diffusion of the Industrial Revolution," *American Economic Journal: Macroeconomics*, 1–25.

McGrattan, E. R. and E. C. Prescott (2009): "Openness, technology capital, and development," *Journal of Economic Theory*, 144, 2454–2476.

Piketty, T., E. Saez, and S. Stantcheva (2014): "Optimal taxation of top labor incomes: A tale of three elasticities," *American economic journal: economic policy*, 6, 230–271.

Romer, D. (2011): *Advanced macroeconomics*, McGraw-Hill/Irwin.