Lecture 16

Economic Growth, Information and Cities

16.1 What is Economic Growth? Economic Theories (and their Flaws)

IUS 9.1

Economic Growth

where do economic growth rates come from?

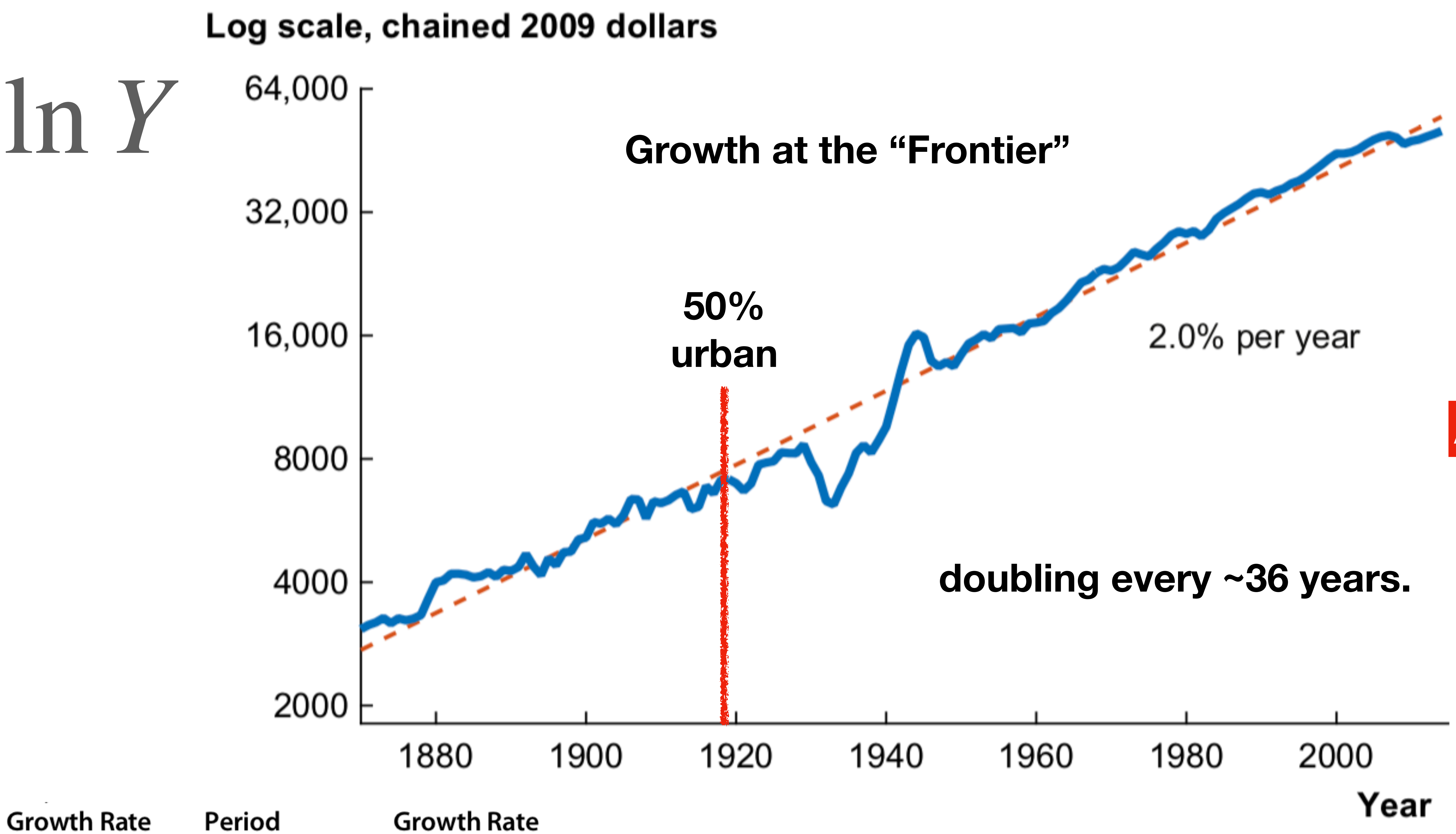
$$\frac{dY}{dt} = \eta Y$$

Exponential Growth: 2-3% a year for USA

noisy, scale dependent, variable

inequality

Economic Growth USA: 1870-2016



AMAZING !!

Period	Growth Rate	Period	Growth Rate
1870–2007	2.03	1973–1995	1.82
1870–1929	1.76	1995–2007	2.13
1929–2007	2.23		
1900–1950	2.06	1995–2001	2.55
1950–2007	2.16	2001–2007	1.72
1950–1973	2.50		
1973–2007	1.93		

Note: Annualized growth rates for the data shown in Fig. 1.

Jones (2016)

https://www.nber.org/papers/w21142

We have now seen the nature of economic growth:

Exponential random processes

Recall: $\gamma = \eta - \sigma^2/2$

Growth rate

at different scales

Inequality → ***Knowledge* and Optimal Investment**

η

average growth rate

maximize

σ

volatility

minimize

control: households, government

Objectives: change through new knowledge ↔ stability, resilience

“Stylized” Facts about (national) Economic Growth

1) *Increases in the extent of the market*. Increased flows of goods, ideas, finance, and people—via globalization, as well as urbanization—have increased the extent of the market for all workers and consumers.

urban systems

“Smith’s Theorem”: wealth is proportional to the extent of “the market”

2) *Accelerating growth*. For thousands of years, growth in both population and per capita GDP has accelerated, rising from virtually zero to the relatively rapid rates observed in the last century.

3) *Variation in modern growth rates*. The variation in the rate of growth of per capita GDP increases with the distance from the technology frontier.

see next lecture

4) *Large income and total factor productivity (TFP) differences*. Differences in measured inputs explain less than half of the enormous cross-country differences in per capita GDP.

wealth is NOT from labor or capital

5) *Increases in human capital per worker*. Human capital per worker is rising dramatically throughout the world.

=education and training

6) *Long-run stability of relative wages*. The rising quantity of human capital, relative to unskilled labor, has not been matched by a sustained decline in its relative price.

education does not depreciate (much)

Jones and Romer (2010)

https://www.nber.org/papers/w15094

The Economy as a Production Device

(basic economic theory)

Cobb-Douglas production function

$$Y(t) = A(t)L^{\alpha}(t)K(t)^{1-\alpha}$$

total production
GDP

total factor
productivity
TFP

labor

capital

This is like a recipe, say to bake a cake

Each unit of produced output needs both labor and capital
in some fixed proportion

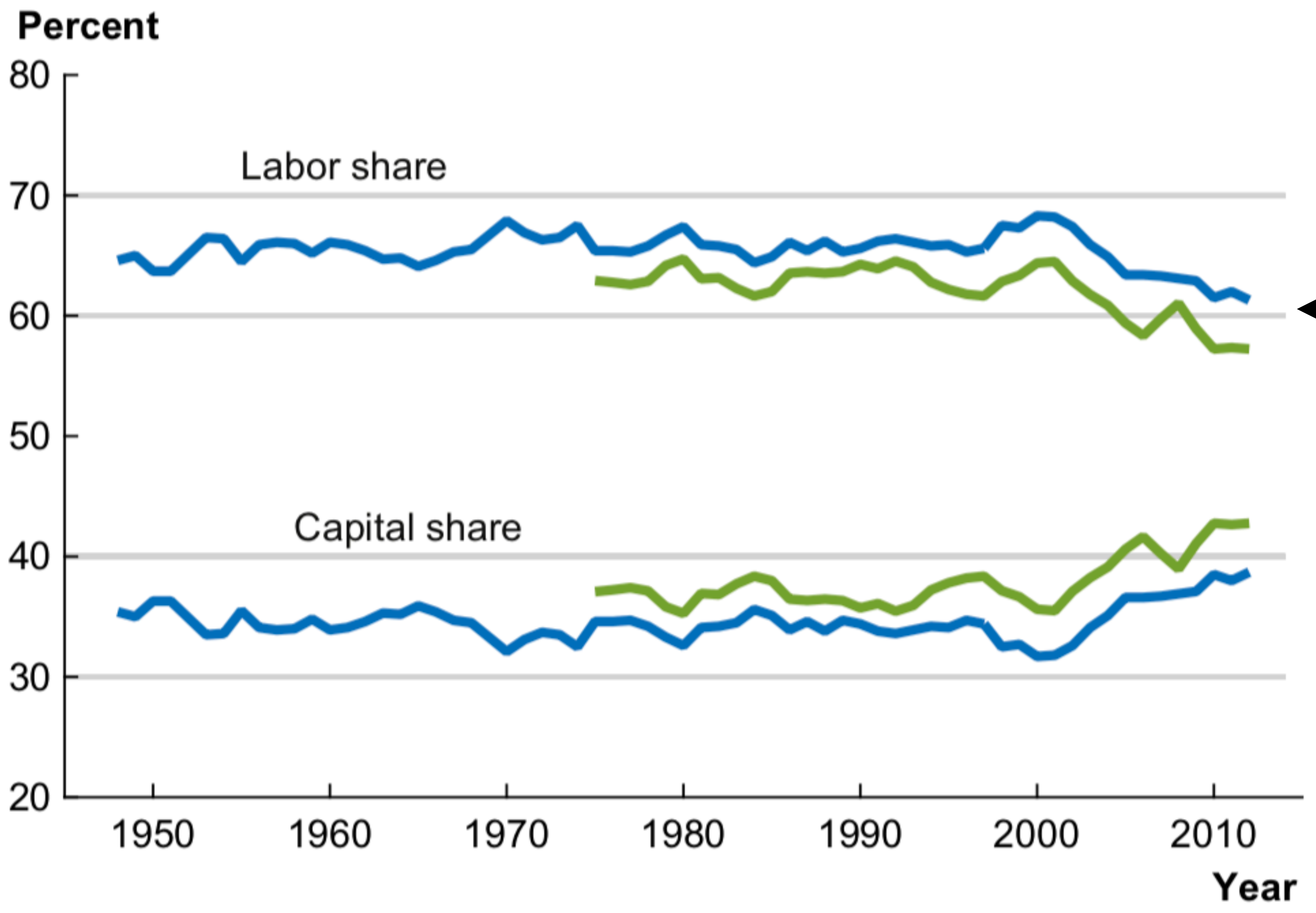
$$\frac{\alpha}{1-\alpha}$$

$$Y(t) = W(t) + R(t)$$

total income **wages** **rents (profits)**

$$1 = \frac{W(t)}{Y(t)} + \frac{R(t)}{Y(t)} = \alpha + (1 - \alpha)$$

fraction of income given to wages



α

remember Piketty and Stieglitz

Jones 2016

https://www.nber.org/papers/w21142

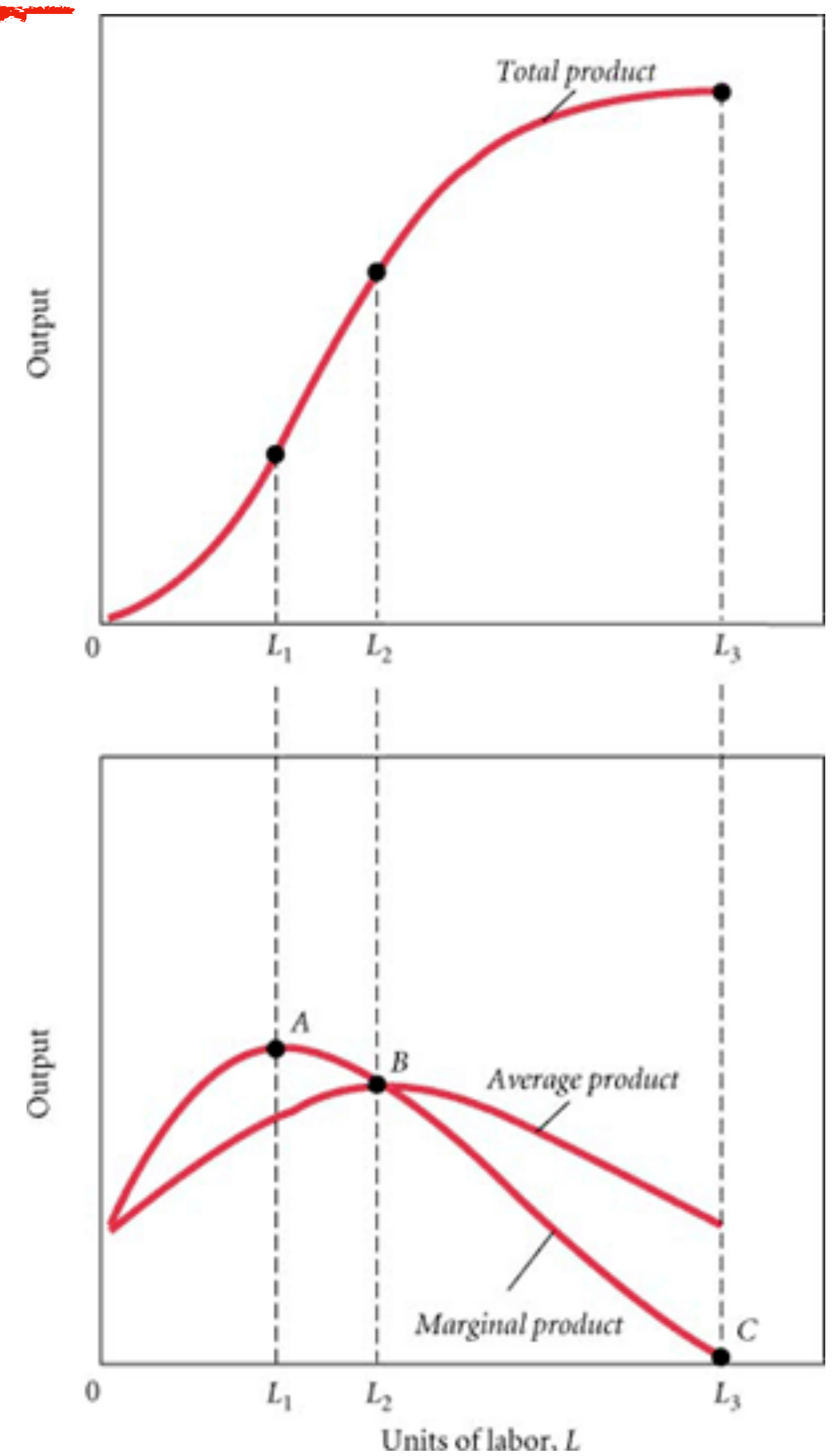
Extensive Growth

diminishing returns

Diminishing returns

From Wikipedia, the free encyclopedia

In economics, **diminishing returns** is the decrease in the marginal (incremental) output of a production process as the amount of a single factor of production is incrementally increased, while the amounts of all other factors of production stay constant.



$$Y \sim L^{\alpha}, \quad \alpha < 1$$

Negative feedback !!

slows down growth

stabilizes the economy

"General Equilibrium"

marginal

$$\frac{d}{dL} Y \sim L^{\alpha-1}$$

Deriving the Production Function

$$Y(t) = W(t) + R(t)$$

take the variation: $dY(t) = dW(t) + dR(t)$

$$\frac{dY(t)}{Y(t)} = \frac{W(t)}{Y(t)}\frac{dW(t)}{W(t)} + \frac{R(t)}{Y(t)}\frac{dR(t)}{R(t)} = \alpha\frac{dW(t)}{W(t)} + (1-\alpha)\frac{dR(t)}{R(t)}$$

$$Y(t) = Y_0 W^{\alpha}(t) R^{1-\alpha}(t) \longrightarrow R = rK, \quad W = wL$$

rent from capital **wages**

$$\boxed{Y(t) = A(t)L^{\alpha}(t)K^{1-\alpha}(t)}$$ **with** $A(t) = Y_0 w^{\alpha}(t) r^{1-\alpha}(t)$

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0058407

$$\frac{d}{dt}\ln Y(t) = \frac{d}{dt}\ln A(t) + \alpha\frac{d}{dt}\ln L(t) + (1-\alpha)\frac{d}{dt}\ln K(t)$$

economy's growth rate

population growth rate

capital growth rate

what we want to know

extensive growth

not very interesting or important

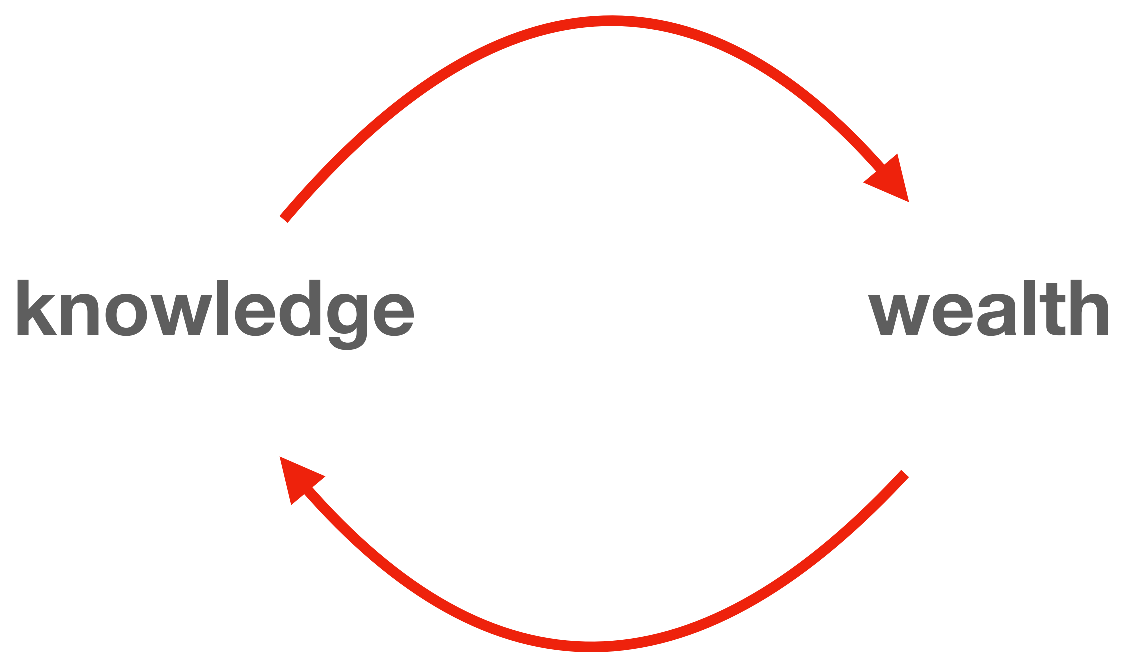
intensive growth

This is the interesting question!!

what sets the growth in *A*?

total factor productivity

Positive Feedback !



Open-Ended Growth

Harvard Business Review

FINANCIAL MANAGEMENT

Increasing Returns and the New World of Business

by W. Brian Arthur

FROM THE JULY–AUGUST 1996 ISSUE

$$\frac{d}{dt}\ln Y(t) \sim \frac{d}{dt}\ln A(t)$$

no reason for slow down !!

Our understanding of how markets and businesses operate was passed down to us more than a century ago by a handful of European economists—Alfred Marshall in England and a few of his contemporaries on the continent. It is an understanding based squarely upon the assumption of diminishing returns: products or companies that get ahead in a market eventually run into limitations, so that a predictable equilibrium of prices and market shares is reached. The theory was roughly valid for the bulk-processing, smokestack economy of Marshall's day. And it still thrives in today's economics textbooks. But steadily and continuously in this century, Western economies have undergone a transformation from bulk-material manufacturing to design and use of technology—from processing of resources to processing of information, from application of raw energy to application of ideas. As this shift has occurred, the underlying mechanisms that determine economic behavior have shifted from ones of diminishing to ones of *increasing* returns.

https://hbr.org/1996/07/increasing-returns-and-the-new-world-of-business

OK, but what is in *A* that can grow exponentially?

Romer (1990)

https://www.jstor.org/stable/2937632

Answer: Knowledge

Why?

decreasing returns occur because inputs are expended (materials and energy)

but *knowledge* is a “non-rival” good

-> “Positive Externality”: knowledge can be used indefinitely without being spent

if *A* is made of knowledge, there are *no decreasing returns* !!

Still need to explain how *A* that can grow exponentially?

simple models and the scale problem:

Jones 1999

https://www.jstor.org/stable/2937632

$$Y(t) = A^{\sigma}(t)L(t)$$ (forget about capital)

growth of *A*:

"knowledge employment"

$$\frac{d}{dt}\ln A(t) = aL_A = g_A$$

$$\sigma > 0$$

$$L = L_A + L_Y$$

total population

knowledge-creator population

worker population

growth of *economy per capita*:

$$g_Y = \frac{d}{dt}\ln\frac{Y(t)}{L(t)} = \sigma a s L$$

$$L_A = sL, \quad L_Y = (1-s)L, \quad 0 < s < 1$$

$$\boxed{g_Y = \sigma a s L_0 e^{g_L t}}$$

totally wrong!

$$\frac{d}{dt}\ln L(t) = g_L \rightarrow L(t) = L_0 e^{g_L t}$$

grows exponentially!!

conundrum:

A must grow exponentially in time to match growth of GDP

Measurements of knowledge also are observed to grow exponentially:

populations of researchers

papers

patents

These quantities set the growth rate of *A*: exponential of exponential

WRONG !!

if any of these drive the growth of *A*, *it will grow too fast !*

This turns out to be a general issue, not yet solved:

Questions?

Who’s knowledge?

How is it created?

How is it integrated in production?

Bob Lucas

https://www.sciencedirect.com/science/article/pii/0304393288901687

Jane Jacobs

It has to be a *collective* good:

“external human capital”

“Institutions”

Acemoglu and Robinson
https://www.nber.org/papers/w10481

“What can people be paying Manhattan or downtown Chicago rents *for,* if not for being near other people?”

As Jacobs has rightly emphasized and illustrated with hundreds of concrete examples, much of economic life is 'creative' in much the same way as is 'art' and 'science'.

New York City's garment district, financial district, diamond district, advertising district and many more are as much intellectual centers as is Columbia or New York University.

The specific ideas exchanged in these centers differ, of course, from those exchanged in academic circles, but the process is much the same. To an outsider, it even *looks* the same: A collection of people doing pretty much the same thing, each emphasizing his own originality and uniqueness.

Considerations such as these may convince one of the existence of **external human capital**, and even that it is an important element in the growth of knowledge.

Her emphasis on the role of cities in economic growth stems from the observation that a city, economically, is like the nucleus of an atom: If we postulate only the usual list of economic forces, cities should fly apart. The theory of production contains nothing to hold a city together. A city is simply a collection of factors of production - capital, people and land - and land is always far cheaper outside cities than inside.

It seems to me that the 'force' we need to postulate account for the central role of cities in economic life is of exactly the same character as the 'external human capital' I have postulated as a force to account for certain features of aggregative development.

If so, then **land rents should provide an indirect measure of this force**, in much the same way that schooling-induced earnings differentials provide a measure of the productive effects of internal human capital.

What can people be paying Manhattan or downtown Chicago rents *for,* if not for being near other people?

Lucas (1988) https://www.sciencedirect.com/science/article/pii/0304393288901687

Lucas and “External Human Capital”

$$Y(t) = A(t)K^{1-\alpha}(t)L^{\alpha}(t) \to AK^{1-\alpha}(t)\left[u(t)h(t)L(t)\right]^{\alpha} h_a(t)^{\gamma}$$

fixed “technology”

individual human capital

“external” human capital

diminishing returns

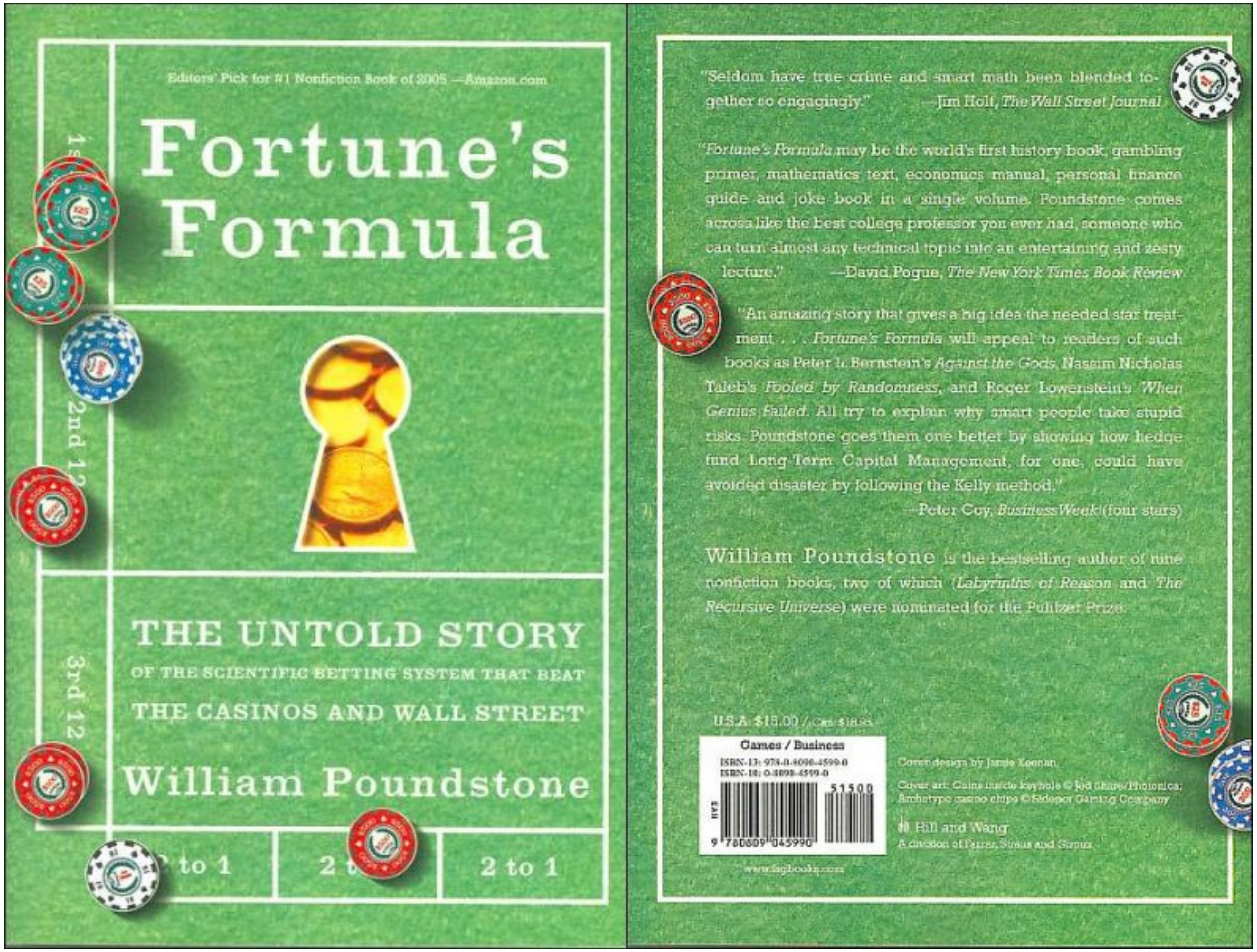
human capital accumulation is a *social* activity,

involving *groups* of people in a way that has no counterpart in the accumulation of physical capital. “

ecological effect

Need a Theory of (productive) Knowledge in Cities

why can the collective system keep growing
even if individual knowledge doesn’t ?



a flawed but fascinating story:

http://www.fortunesformula.com