Data 88: Economic Models

Lecture 4: Production

Announcements - Project 2

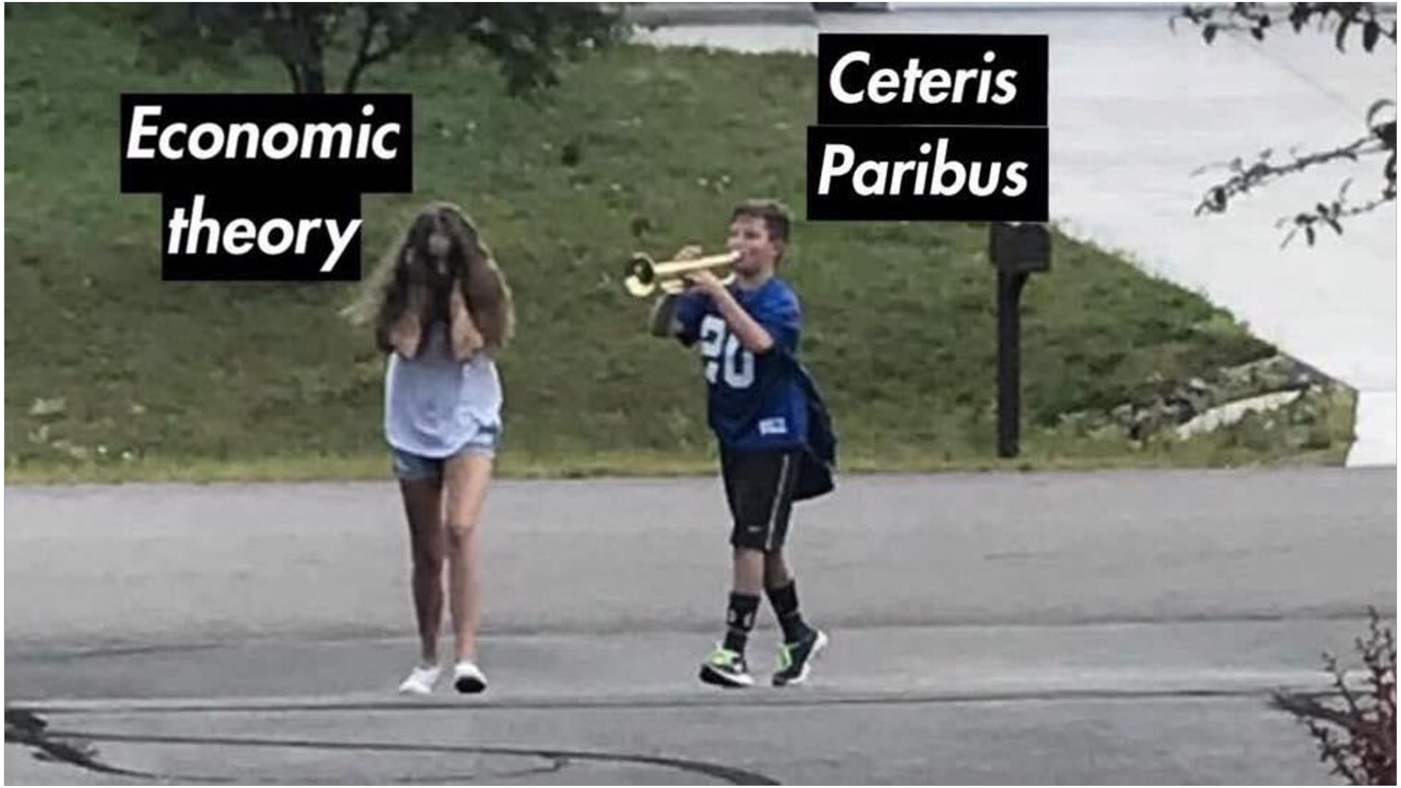
DATA88 EconModels

- Project 2 will be released today
- It will be coding-heavy (Data 8 Project 1-esque), but Lab 4 will greatly help you start

- Whole project due (all 3 parts) 2 weeks from now: October 5 @ 11:59pm
  - Office hours are there for you to get help!
  - We will schedule additional office hours if there is demand
  - Recommended: Finish first 2 parts by Sunday, last part next week

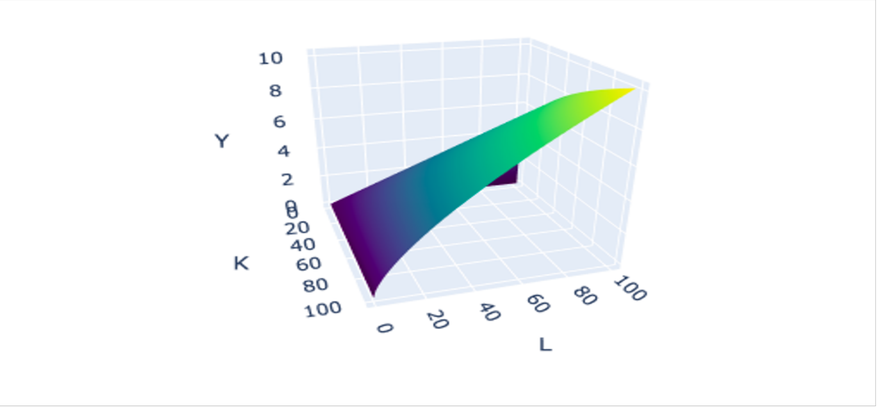
About me

- Graduated in May 2020 with degrees in Economics and Data Science
- Taught this course (Data 88), Data 8 and Econ 100B
- Data Scientist with a Singapore-based company
- If you have any questions about Data Science in industry, please feel free to email me at manikui@berkeley.edu


Economic theory
Ceteris Paribus

Lecture 4 Outline

- Overall
  - Factors of Production
  - Total Factor Productivity
  - Cobb-Douglas Production Functions (3D SURFACES!!!!!)
  - Cross-Country Analysis (this is what the project is)
- Derivation
  - Cobb Douglas
  - Log of Equation
  - Solve for one variable
- Intuition
  - Shifts in A (SLIDERS!!!!!!!)
  - What does α mean?
  - Returns to scale
- Lab time



Name all of the macroeconomic indicators you know

GDP (/capita)

u

π (inflation), CPI

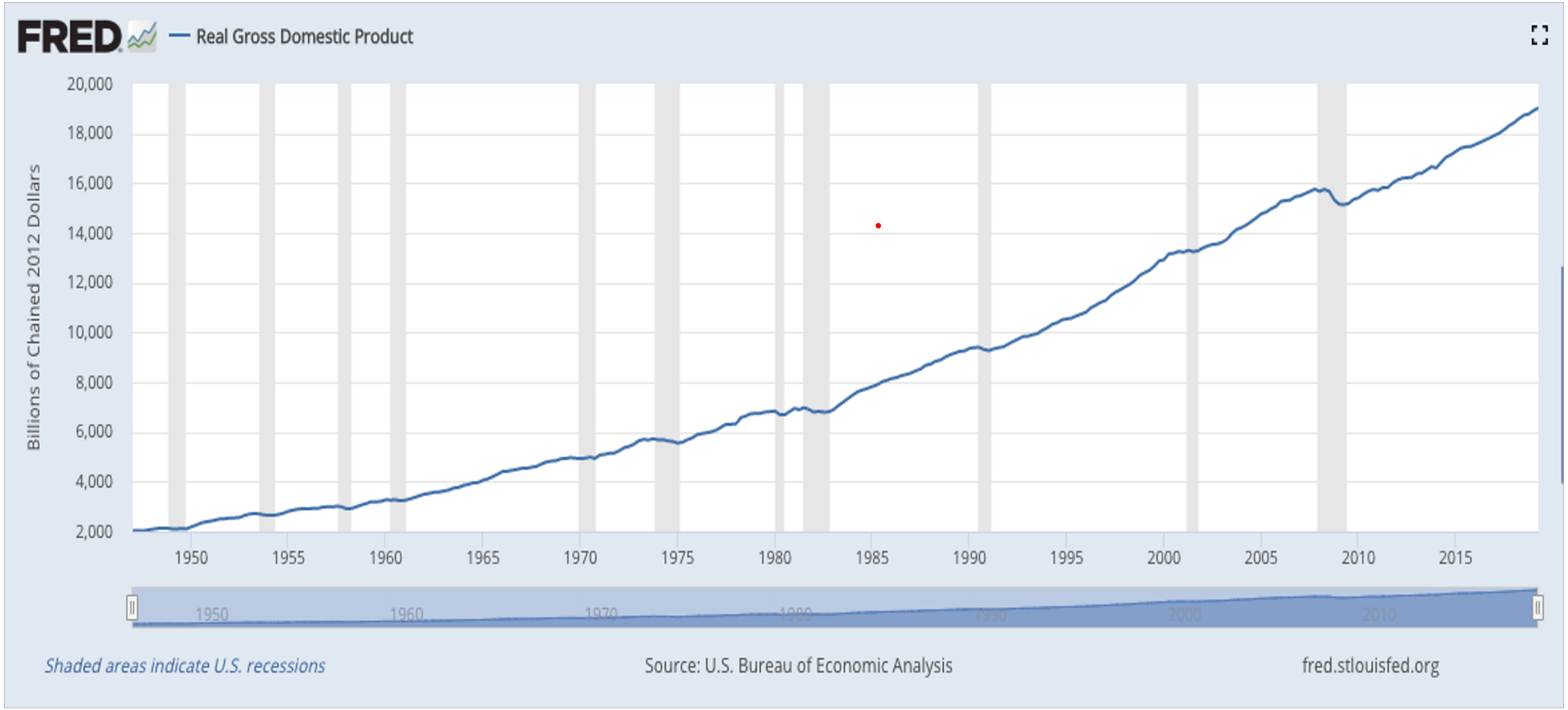
r

IM/EX

CO_2

m1, m2

What is GDP?



How do we calculate it?

Ways to Calculate GDP

- Income approach

  rent, wages, r, profits

- Expenditure approach → $C+I+G+EX-IM$

- **Production approach**

Production in the Economy

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- What is production?

inputs → $\boxed{}$ → output (GDP)

- How do we quantify a country's production?

inputs · prices

- Why would it be important to calculate this?

- what sectors need help

Inputs (or Factors) of Production

Let's make a list of **all** the resources that go into producing and selling an iPhone:

metals (K)

labour (slave) (L)

silicon (K)

R&D (A)

shipping (K, L)

sales (L)

I.P. (A)

packaging (K, L)

stores (K)

factories (K)

education (A)

K - capital

L - labour

A - TFP (tech.)

Image source: https://store.storeimages.cdn-apple.com/4982/as-images.apple.com/is/refurb-iphoneX-spacegray_AV1?wid=1144&hei=1144&fmt=jpeg&qlt=80&op_usm=0.5,0.5&.v=1548459945536

Fundamental Idea

A nation's output is a function of the amount of the factors of production that are utilized in its economy; that is to say output is a function of labor and capital, scaled by some value A.

$f(K, L)$

TFP

$$\boxed{Y = A \cdot f(K, L)}$$

What could A be? Why is it on the outside of the production function?

Total Factor Productivity (TFP) (A)

- Technology or research and development
- A country with a high TFP can producer far more goods and services than another country with a lower TFP but the same amount of capital and labor

$A=2$ vs. $A=1$

K, L

- Differences between TFP and other factors of production
  - "Scales" production by some factor A - creates proportional increase in output
  - Technology is non-rivalrous (more than one person can use it)
  - Technology is non-excludable (cannot prevent other people from using it)
  - Ordinal measure
    ↳ comparison

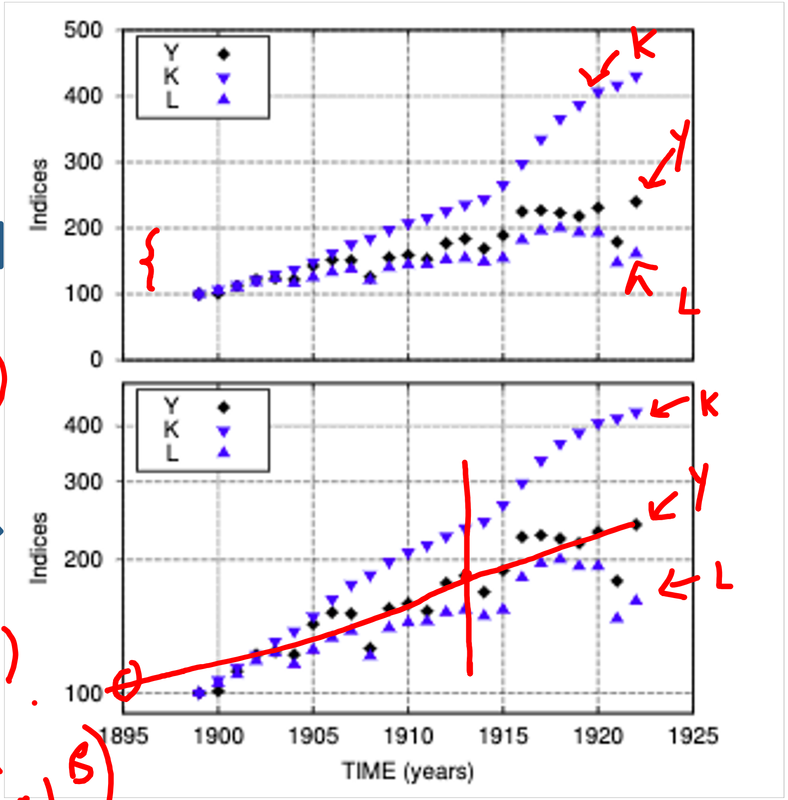
How the equation was formulated

weighted avg.

Based on the graphs to the right, what would F(K, L) look like?

What assumptions can we make about Y, K and L?

$\ln(\cdot)$



$$Y = F(K, L) \cdot A$$

$$\ln(Y) = \underline{int} + \underline{\alpha} \cdot \ln(K) + \underline{\beta} \cdot \ln(L).$$

$$Y = \underbrace{e^{int}}_{\text{"A"}} \cdot (K^{\alpha} \cdot L^{\beta})$$

(Cobb and Douglas did these calculations without computers 😮)

Image source: Hawkins' 100B; Lecture 4, Slide 9

Cobb-Douglas Production Functions

$$f(K, L) = K^{\alpha} L^{\beta}$$
$$\Rightarrow Y = A \cdot f(K, L) = AK^{\alpha} L^{\beta}$$

- For simplicity sake, we will assume constant returns to scale.
  That is, $\alpha + \beta = 1$. This allows us to rewrite the function in the following way:

- Where else will we see this function?

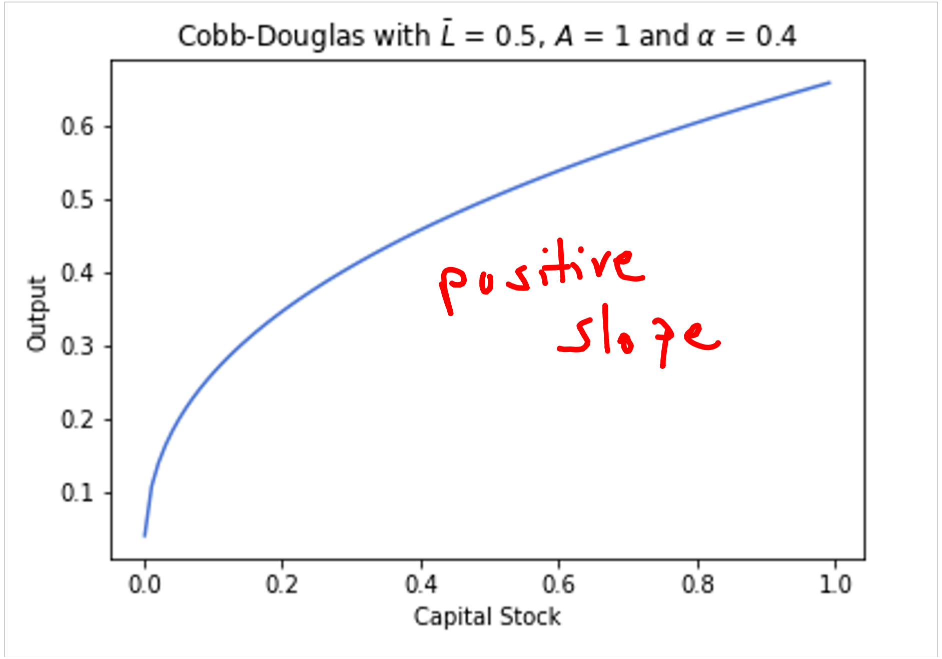
utility

$$\boxed{Y = AK^{\alpha} L^{1-\alpha}}$$

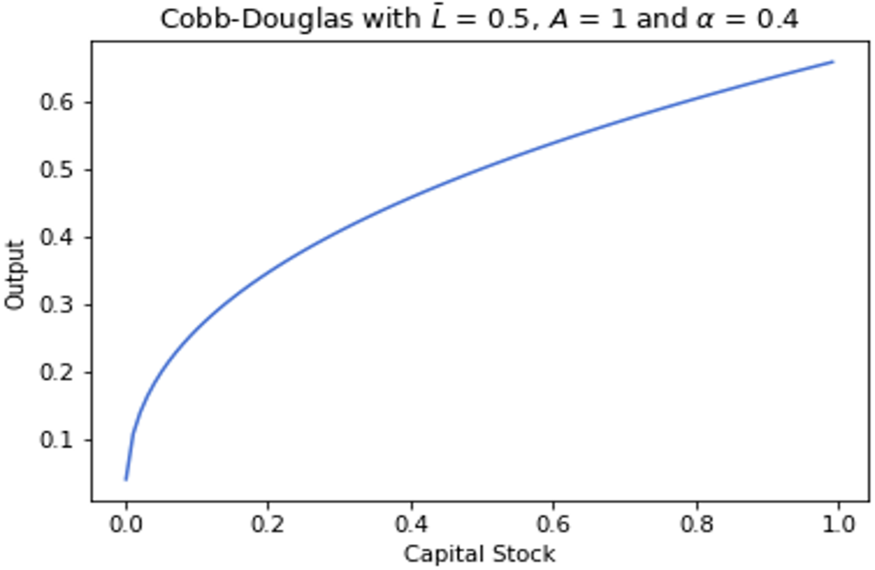
Capital

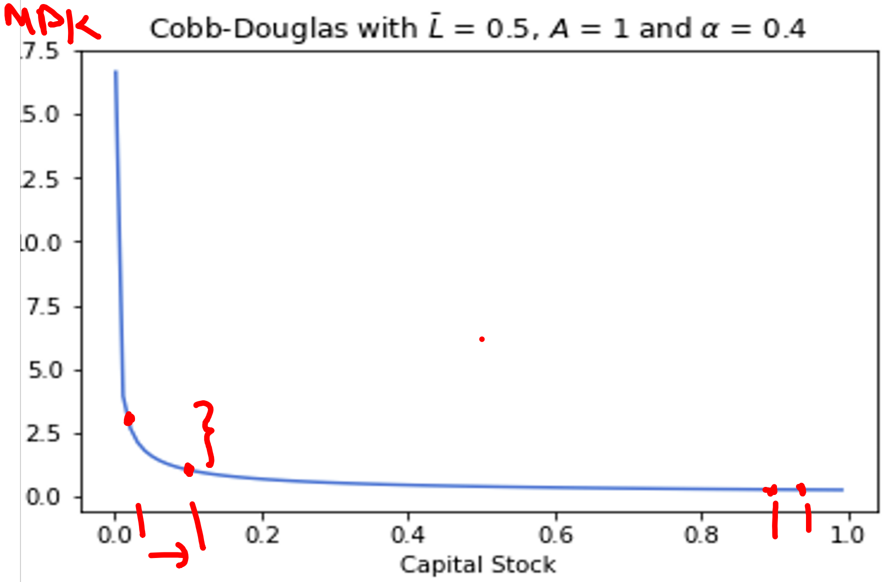
A monetary value of the stock or value of all productive, physical assets in an economy **(not bonds, stocks or other financial products)**

Increasing Returns to Capital
(What does that mean?)



$Y = AK^{\alpha} L^{1-\alpha}$





Diminishing marginal returns to capital

What is the intuition behind this?

How do we get the price of capital?

$$MPK = \frac{\partial Y}{\partial K} = A \alpha K^{\alpha-1} L^{1-\alpha}$$

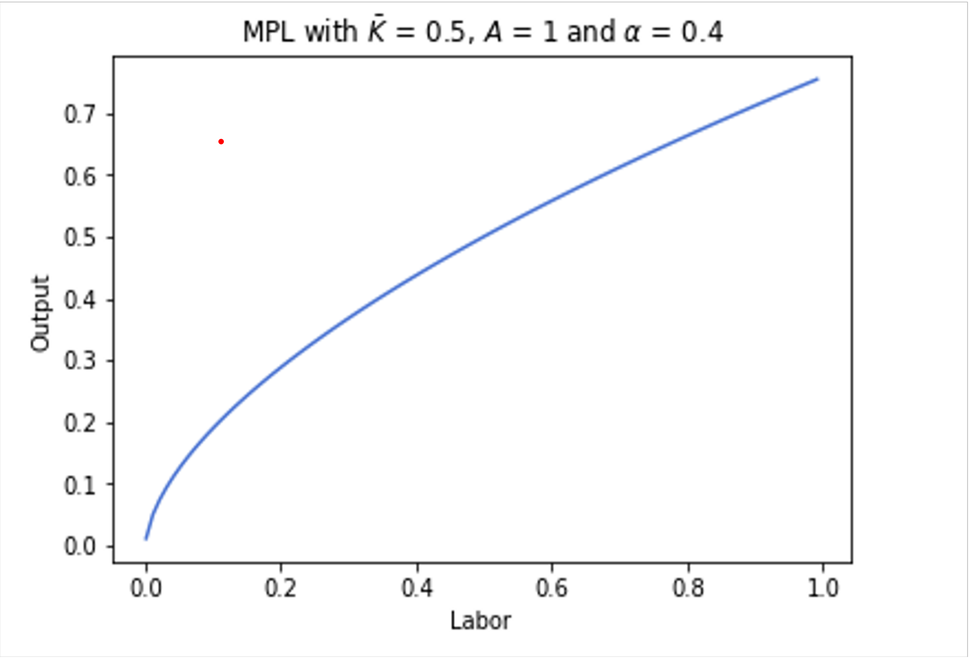
$$\boxed{= A\alpha \left(\frac{L}{K}\right)^{1-\alpha}}$$

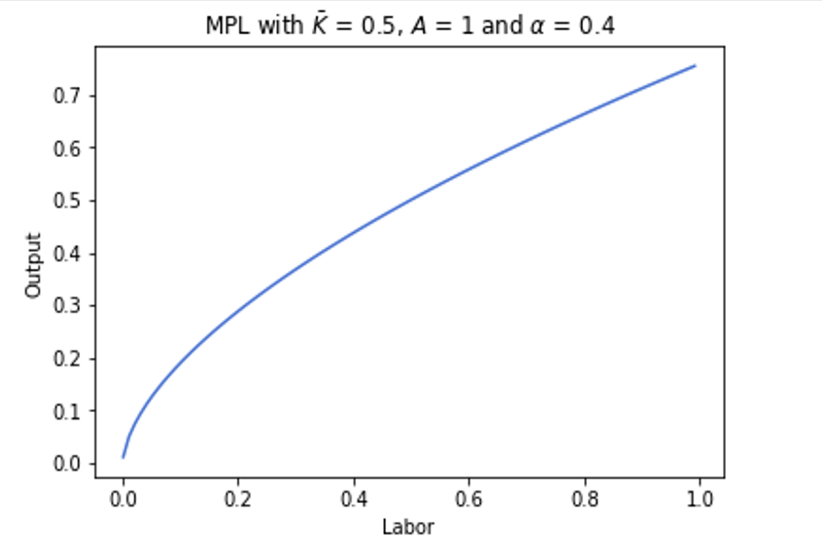
$MR \geq MC$

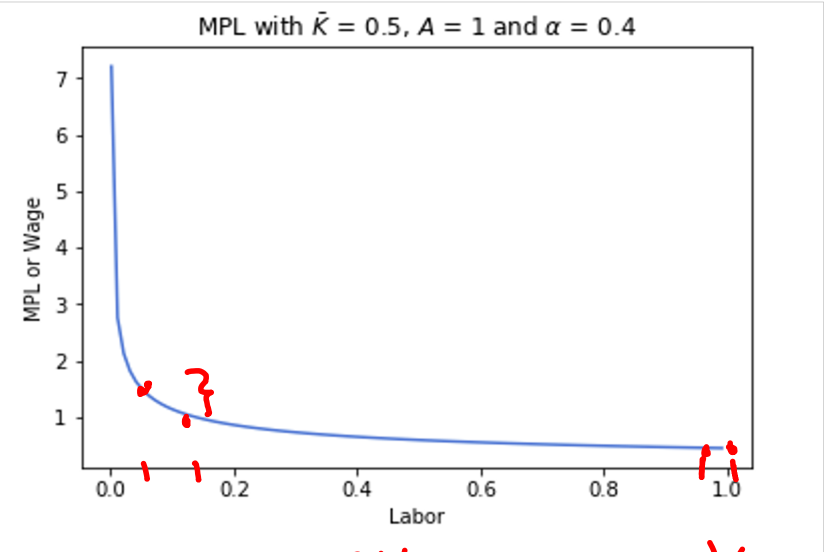
$$MR = MC \Rightarrow \boxed{\underline{P} \cdot \underline{MPK} = r}$$

The number of hours worked by all individuals who are willing and able to work within a country for a given year

Increasing Returns to Labor
(What does that mean?)







* Diminishing Marginal Returns to Labor

What is the intuition behind this?

How do we get the price of labor?

$$MPL = \frac{\partial Y}{\partial L} = A(1-\alpha)\left(\frac{K}{L}\right)^{\alpha}$$

$$MR = MC$$

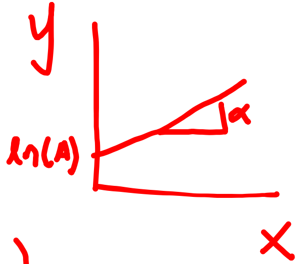
$$\boxed{P \cdot MPL = w}$$

$$Y = A K^{\alpha} L^{\beta}$$

Cross-Country Comparisons

Cobb and Douglas found that a country's output can be modeled very well as a weighted average of the log of capital and labor.

How can we rearrange the function to only be in terms of one variable?



$$Y = A\underline{K}^{\alpha}\underline{L}^{1-\alpha}$$

$$\ln(Y) = \ln(A) + \alpha \ln(K) + (1-\alpha)\ln(L)$$

$$= \ln(A) + \underline{\alpha \ln(K)} + \underline{\ln(L)} - \underline{\alpha \ln(L)}$$

$$\ln(Y) - \ln(L) = \ln(A) + \alpha\left[\ln(K) - \ln(L)\right]$$

$$\ln\left(\frac{Y}{L}\right) = \ln(A) + \alpha \ln\left(\frac{K}{L}\right)$$

$$b + mx$$

Cross-Country Comparisons (cont.)

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$$\ln\left(\frac{Y}{L}\right) = \ln(A) + \alpha \ln\left(\frac{K}{L}\right)$$

0.7 0.3

$Y = AK^{\alpha} L^{\beta}$

How can we use the above function to compare countries?

1 α changes → β changes → Capital vs. labor intensive

2 A differences → technology

What are possible problems with the function?

α, A fixed

$Y = AK^{\alpha} L^{\beta}$

Romer ⇒ ΔA over time

Shifts in A

ΔA?

- Supply or Technology shocks
  - Natural environment ← COVID
  - Energy prices   war
  - Significant financial crises
- What would happen to output?

→ gov't intervention

- Can anyone think of any real-world examples?

  – OPEC oil crises

  – subsidizing technology

What does alpha mean?

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Output elasticities of capital and labor: measure the responsiveness of output to a change in the levels of either labor or capital, holding all else constant.

$$Y = AK^{\alpha}L^{1-\alpha}$$

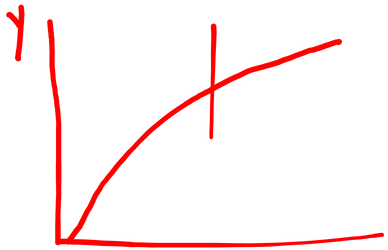
Let us assume constant returns to scale. What does $\alpha > 0.5$ mean?

labour intensive

Returns to scale

Constant Returns to Scale: $\boxed{\alpha + \beta = 1}$

$$c \cdot Y = f(c \cdot K, c \cdot L)$$

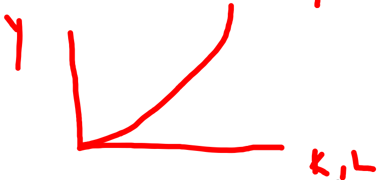


Decreasing Returns to Scale: $\alpha + \beta < 1$

$$cY < f(cK, cL)$$

Increasing Returns to Scale: $\alpha + \beta > 1$

$$cY > f(cK, cL)$$



What would the last two look like if their production functions were plotted?

Lab Time!

Open up Lab 4 and work through the notebook. We'll be here to help.

The questions will be **very** helpful in preparing your for Project 2!