ECON B225: ECONOMIC DEVELOPMENT

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Early Models of Growth and Development

“All models are wrong, but some are useful.”

– George E.P. Box

Introduction

- **This class covers early models of growth and development that predate what has become dominant, the Solow Model (also called the "Neoclassical Growth Model"), and so-called "endogenous growth models"**
- **We'll look at two early models**
  1. The Lewis Two Sector Model, and
  2. The Harrod-Domar Model

Motivation

- **Why look at these if Solow has supplanted them?**
- **The Lewis Model describes a different type of structural transformation than Solow**
  - Still helpful when thinking about relationships between different sectors of the economy and how they evolve as an economy develops
- **Harrod-Domar is fundamentally flawed**
  - But highly influential
  - Good example of poor conclusions and their relationship to bad assumptions
  - Good to relate to Solow

Historical Context

- **1940s and 1950s: Economists were thinking about growth in terms of the US experience and the USSR**
  - Characterized by "Capital Fundamentalism" – The idea that economic growth was primarily the result of society accumulating capital
    - Think about the USSR forcing investment into factories and mechanized production
    - Machines and factories were also part of the US story

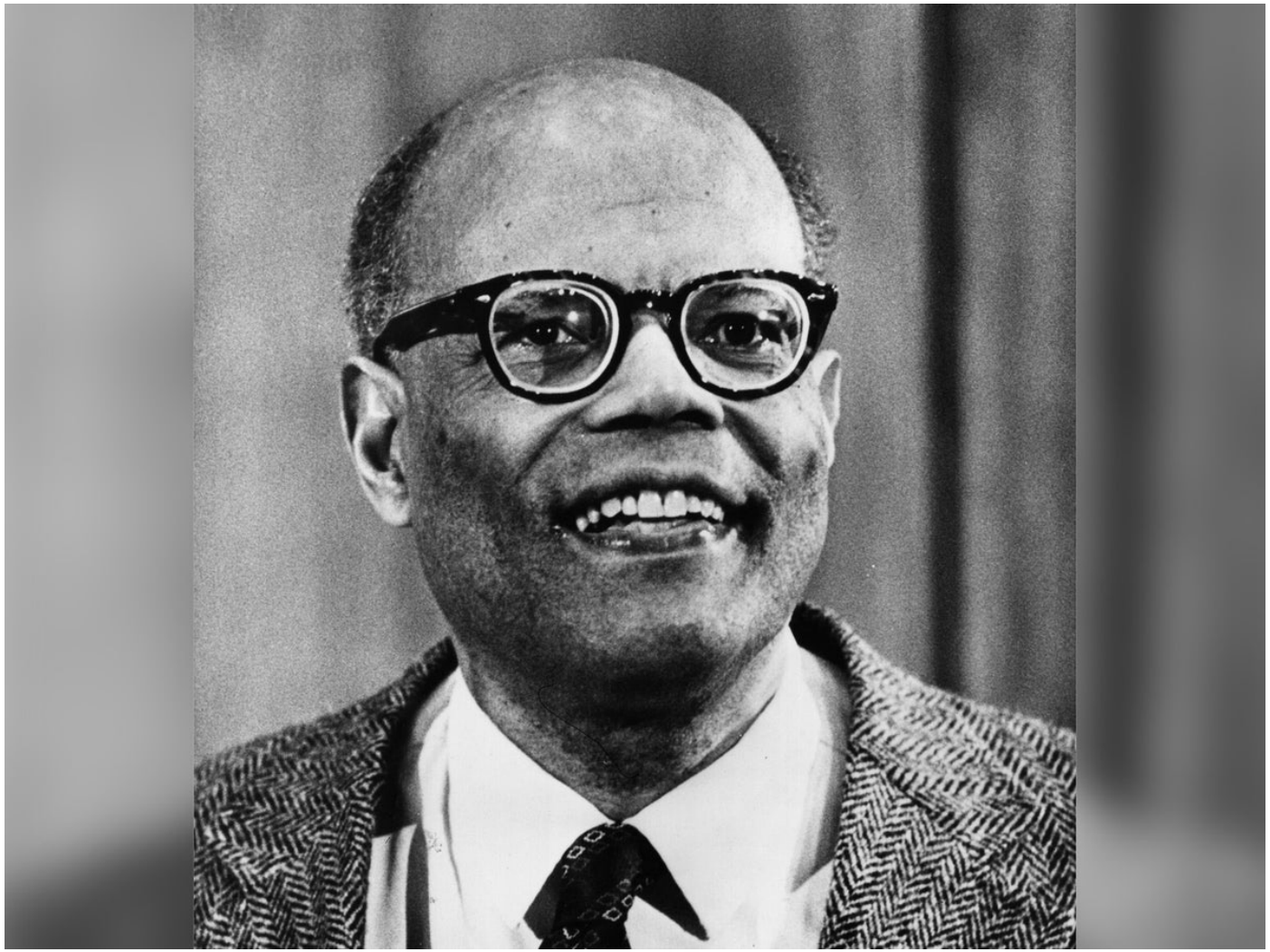
A Note on Economic Models

- **Why use a model at all to answer these questions?**
  - They help us organize our thinking and structure complex ideas
  - Make relationships between important factors explicit
  - They provide a useful framework for analysis
    - Often you will want to build in nuance and complexity once you understand the basic framework
  - Useful guide for empirical investigation
    - Empirical work will often provide insight on how models can be refined

Arthur Lewis

- Born in St. Lucia in 1915
- Nobel Laureate in Economics in 1979
- Trained at the London School of Economics in Industrial Economics
- Helped establish Caribbean Development Bank and the United Nations Development Programme
- Faculty member and/or administrator at Princeton, University of West Indies, University of Guyana

Arthur Lewis

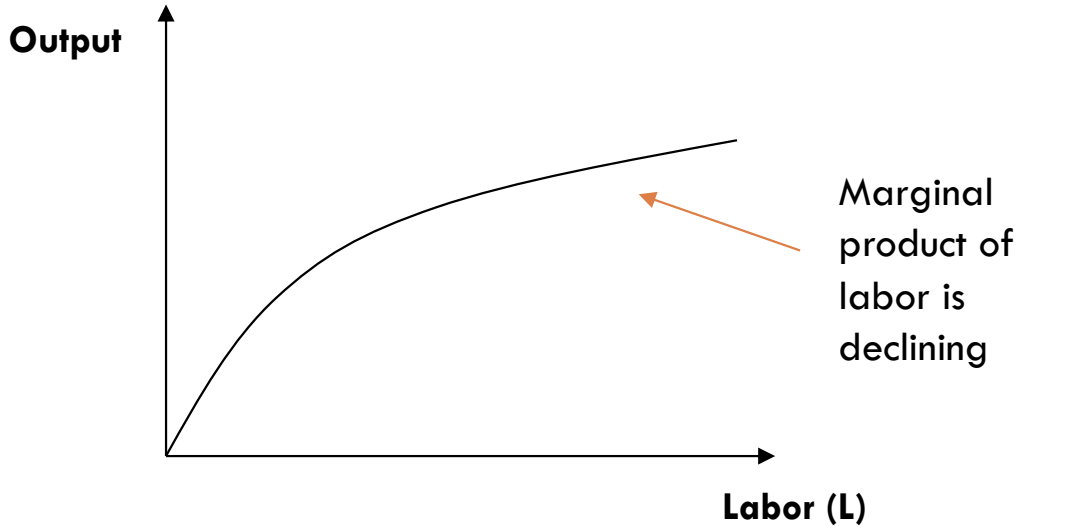


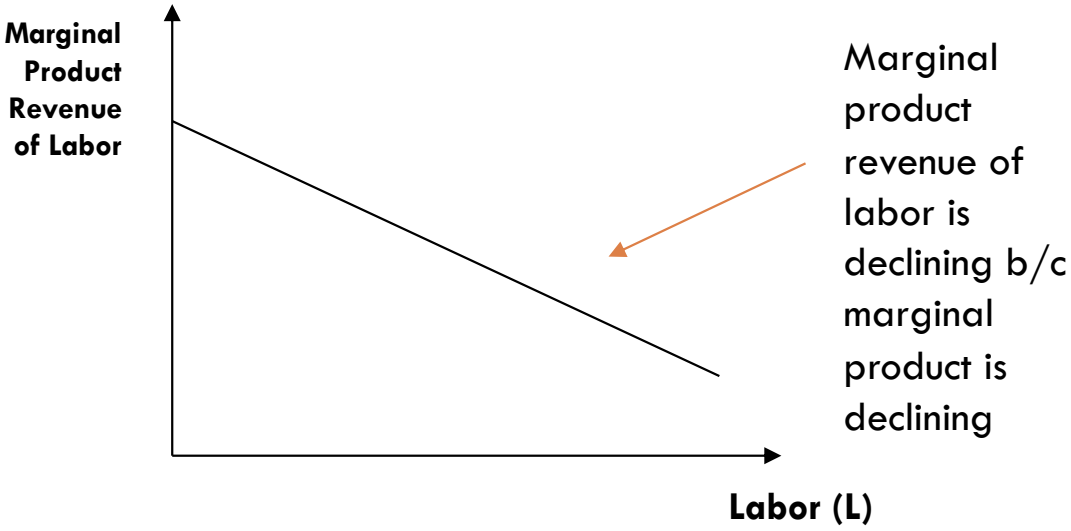
Me at Arthur Lewis's gravesite and memorial at Arthur Lewis Community College in Castries, St. Lucia

ECON 105 Review: Labor Market Basics

- **Recall from ECON 105**
  - In comp. market, marginal product (measured in revenue) = marginal cost (wage), when capital is fixed
  - In comp. market, firms are price takers to marginal revenue = price
- **Demand in the labor market:**
  - Demand for labor comes from firms. So, we can derive demand from attributes of businesses
- **We need to think about the relationship between demand for labor and the marginal product of labor**
- **Recall that the demand curve represents willingness to pay, and thus tracks marginal benefit**

ECON 105 Review: Labor Market Basics





- **So each unit of labor added gets you a positive, but declining amount production back**
- **Firm is competitive and is thus a price take**
- **So each additional unit of production results in that amount of production times the marginal revenue (the price)**
  - This gives the "marginal product revenue" of labor
  - This is also the **marginal benefit** of adding one more unit of labor to the firm
  - So, this line is the **firm's demand curve** for labor

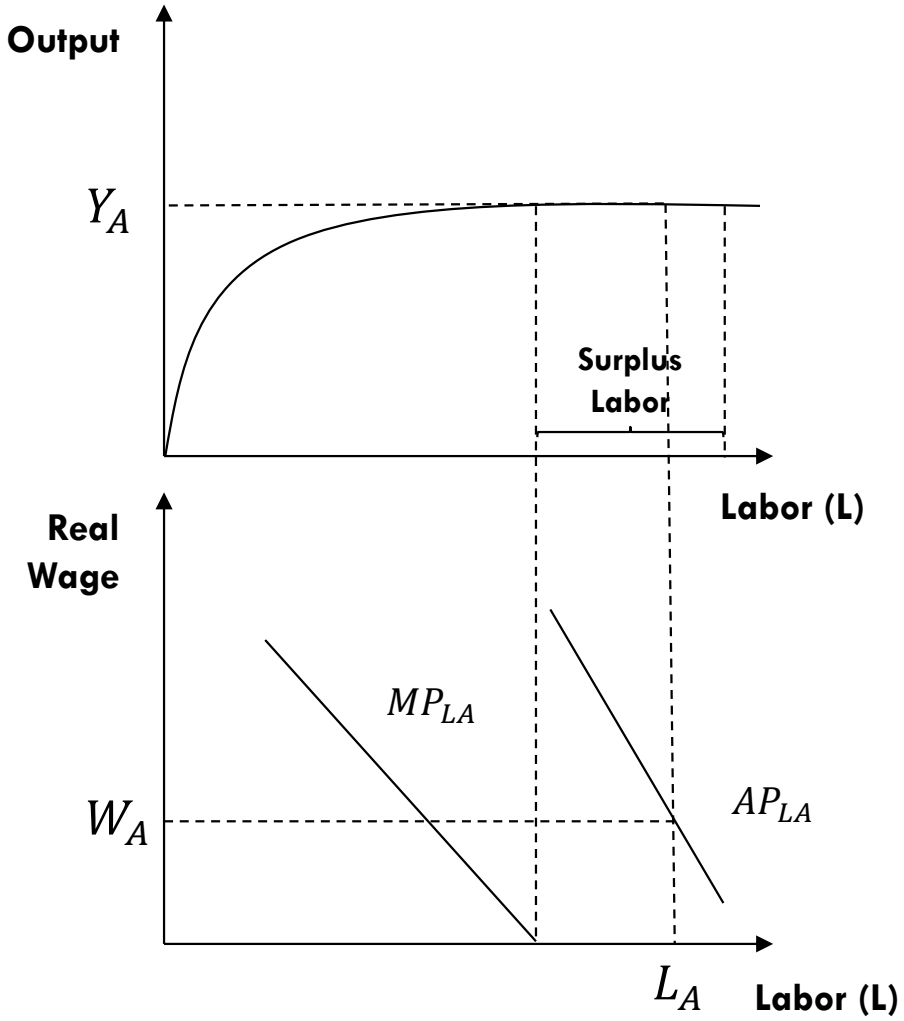
Lewis Model

- **Remember he is coming up with this model trying to explain a situation in low-income countries where,**
  - **There is a huge sector in agriculture, much at the subsistence level**
    - Lots of people are not working all the time (seems like excess labor)
  - **Very low levels of capital-intensive industry in cities**
    - Where this is though, you see people employed and working at capacity

Lewis Model Assumptions

- **Suggests this type of economy is best understood at having dual sectors:**
  1. Agricultural ("Traditional" rural)
  2. Industrial ("Modern" urban)
- **Agricultural Sector Assumptions**
  - Marginal Product of Labor is 0
    - Adding one more unit of labor gets no more production. Even more simply, the land is producing at capacity
  - Noncompetitive: "Wages" are equal to the average product of labor
    - Think of it like this: subsistence farming household farms the land and then distributes income equally among members, so what each worker gets is equal to the average product of labor

What this Means in the Ag. Sector

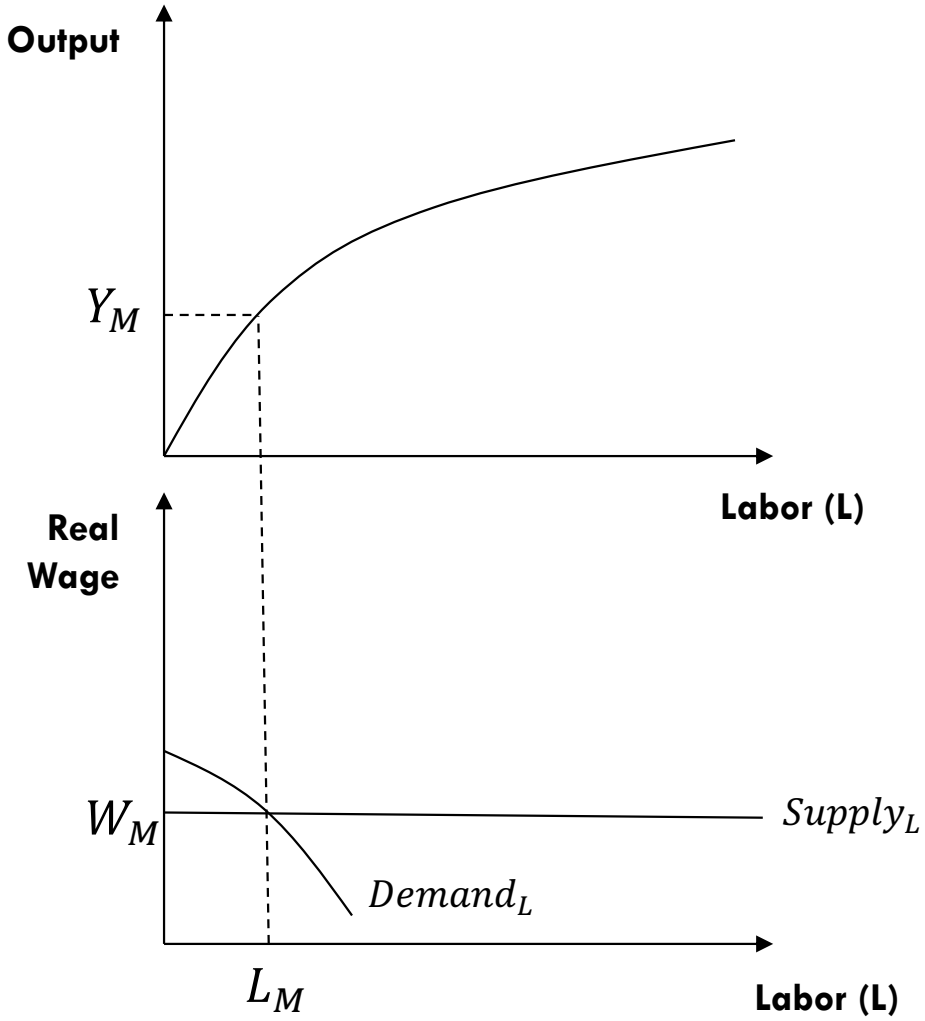


- Low-income country is on the flat part of the production function
- When the flat part of the curve starts, returns from adding labor are determined by the average product of labor

Lewis Model Assumptions

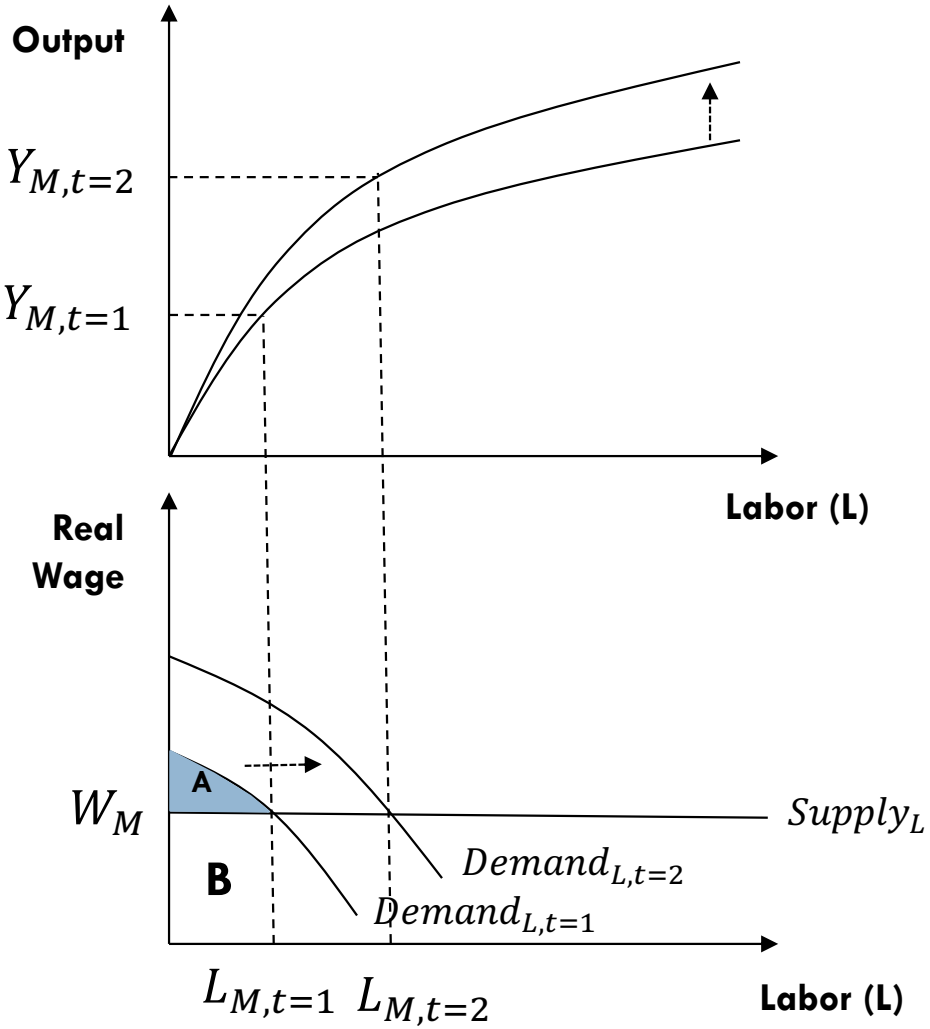
- **Industrial Sector Assumptions:**
  - **Competitive:** Wage is equal to the marginal product of labor
  - **Marginal product of labor is positive (but declining)**
    - Add another unit of labor and you get more production, but less and less for each unit added
  - **Firms reinvest profits** into the business in purchasing new capital and hiring more workers if profitable
  - **Supply of labor is perfectly elastic**
    - Why? Huge amount of labor in the ag. sector, happy to work in industry

What this Means in the Ind. Sector



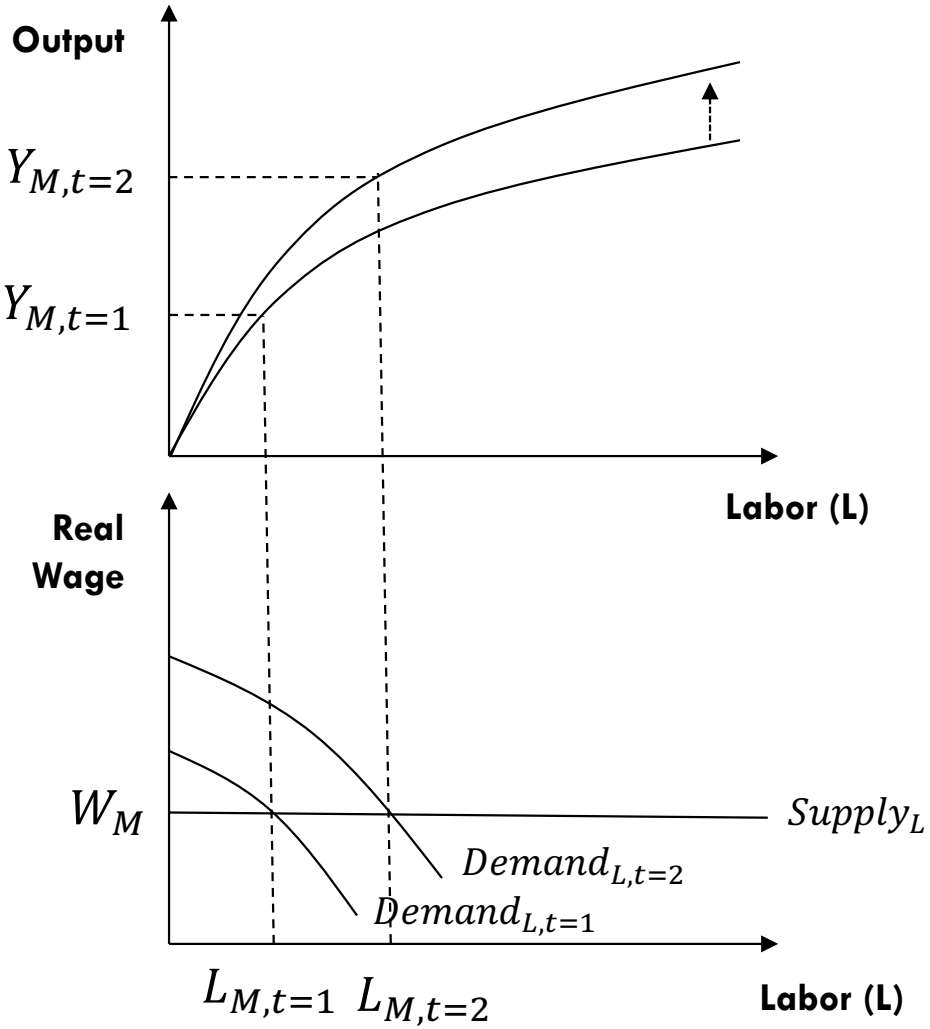
- **These are the only two sectors in the economy, so**
  - $GDP = Y_M + Y_A$
  - $GDP_{PC} = \frac{Y_M + Y_A}{L_M + L_A}$
- **We assume population = labor supply**

Let's Consider the Evolution of an Economy Like This



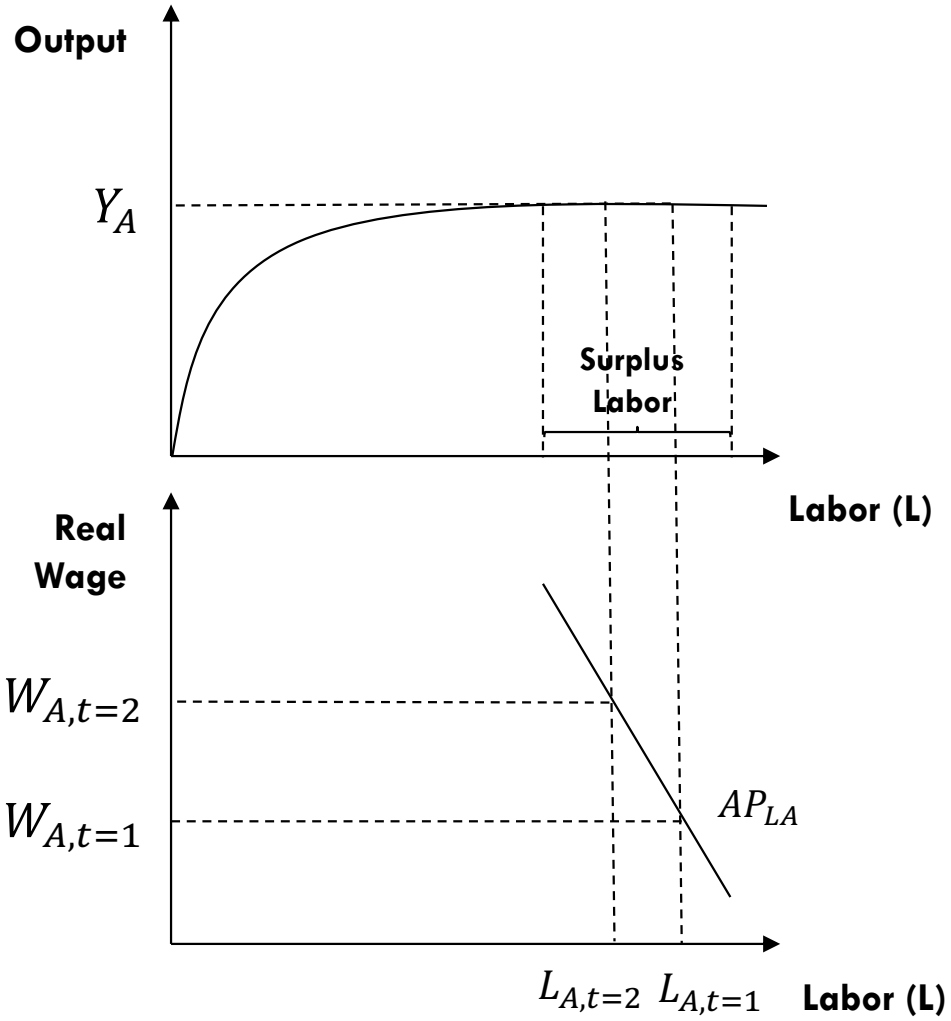
- **Time period 1:**
  - Firm surplus (profits) is **A**
  - Total revenue collected by workers in industry is **B**
- **We assume the firms reinvest in new capital**
  - This makes the marginal product of labor greater for each level of L
  - Increases the demand for labor at each level of L

Let's Consider the Evolution of an Economy Like This



- **What has happened here?**
- **Think specifically about production, wage payouts to workers, and firm profits**
  - Production's increased!
  - Wage rates haven't changed, but more people are earning!
  - Profits have increased!

What Happens in the Ag. Sector?



- **Some potion of L_A leaves and goes to the industrial sector**
  - Y_A stays the same, b/c those units of labor weren't adding to any production
  - There are fewer people to support off of maxed-out ag. production, so average wage increases

What will Happen in $t = 3$?

- **Assuming there is more excess labor in the ag. sector (as drawn)**
  - The same story will repeat itself
    - Formal employment expands, overall production increases, wages in the ag. sector increases
    - Each time the firms reinvest, more people move over to the industrial sector and output increases (growth)
- **Does this ever stop?**
  - Yes. After the industrial sector absorbs all the excess labor in the ag. Sector
    - At this point, the industrial sector will only be able to attract workers by offering a higher wage than what they can earn in agriculture
      - When this is the case, any industrial growth will be offset by declines in ag. output

Implications

- **Growth/Development is a process of transition from agriculture to industry and growth in the capital stock providing more opportunities for that labor to be productive**
- **Development is limited by the excess labor in the ag. sector**
- **Once this is absorbed by the industrial sector, then development stops**
  - Does this seem right? What's wrong, or at least limiting, about this?

Issues with the Lewis Model

- **Assumes that capital investments have a proportional effect on job creation**
  - Possible firms will invest in labor-saving technologies
- **Assumes surplus rural labor and full urban employment**
  - In reality there isn't much surplus rural labor
- **Assumes industrial sector will offer constant wages over time**
  - In reality, wages have gone up in urban centers of low-income countries
- **Assumes diminishing returns to scale in the industrial sector**
  - Again, empirically the opposite seems to be true

The Harrod-Domar Model

- **This is an old, but highly influential, model from the 1940s**
  - Domar originally intended this as a model for business cycles
- **Start with the production function for a country's economy,**

$$Y_c = \frac{K_c}{v} \tag{1}$$

Where Y_c is output in country c, K_c is capital and v is some constant

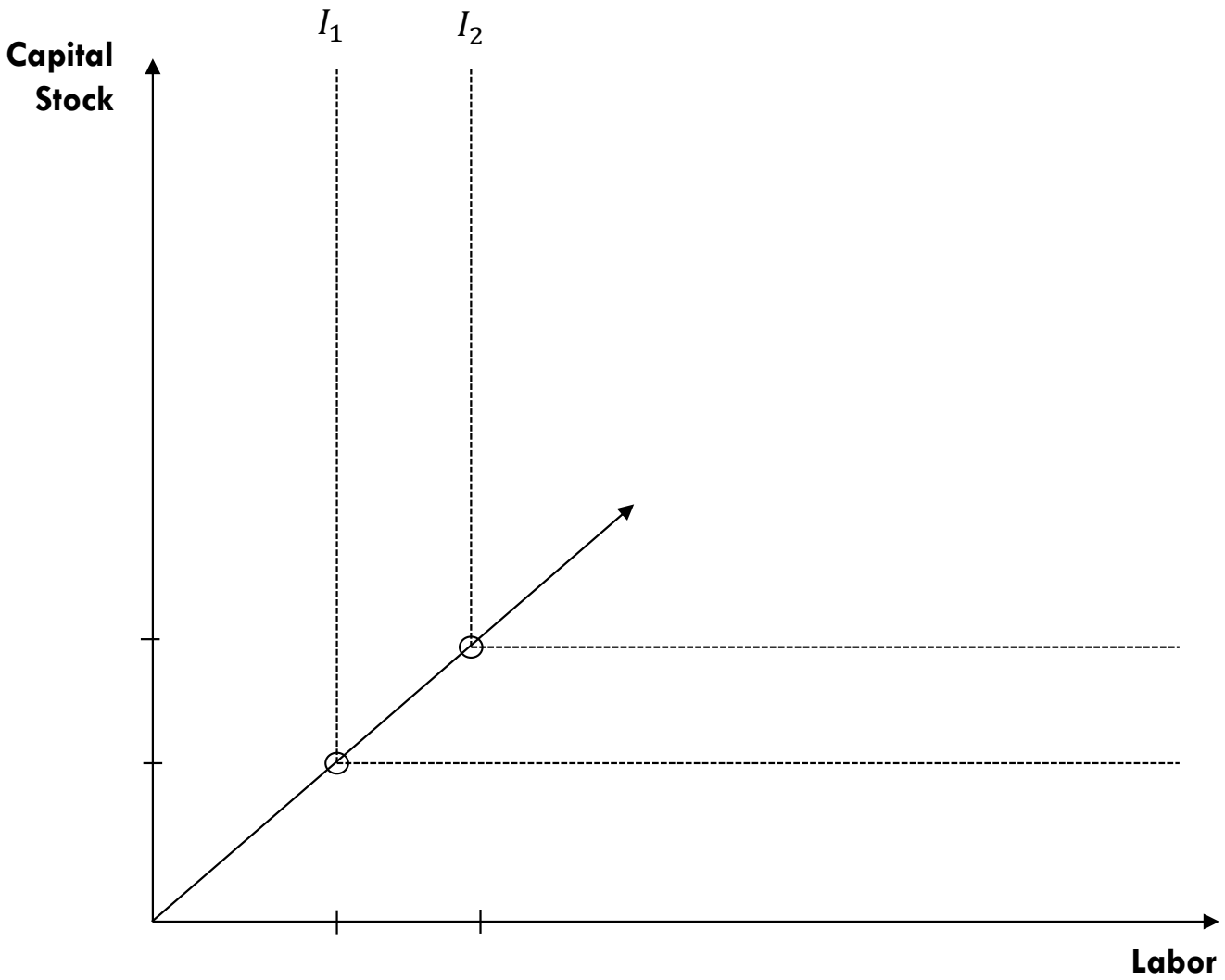
What does this Mean?

- **$\frac{1}{v}$ determines how much production the country gets out of a certain amount of capital**
  - Suppose a country has 30 million USD in capital, and v is 15. What would be the output?
    - 2 million!
- **This is a simple linear production function**
- **It is a "fixed coefficient, constant returns to scale" production function**

What does this Mean?

- **"Fixed coefficient":** v is a constant and does not change
- **"Constant returns to scale":** It doesn't matter if K_c goes from 1 to 5 or from 1,000 to 1005. The effect on Y_c will be the same

Fixed Coefficient, Constant Return to Scale Production Function

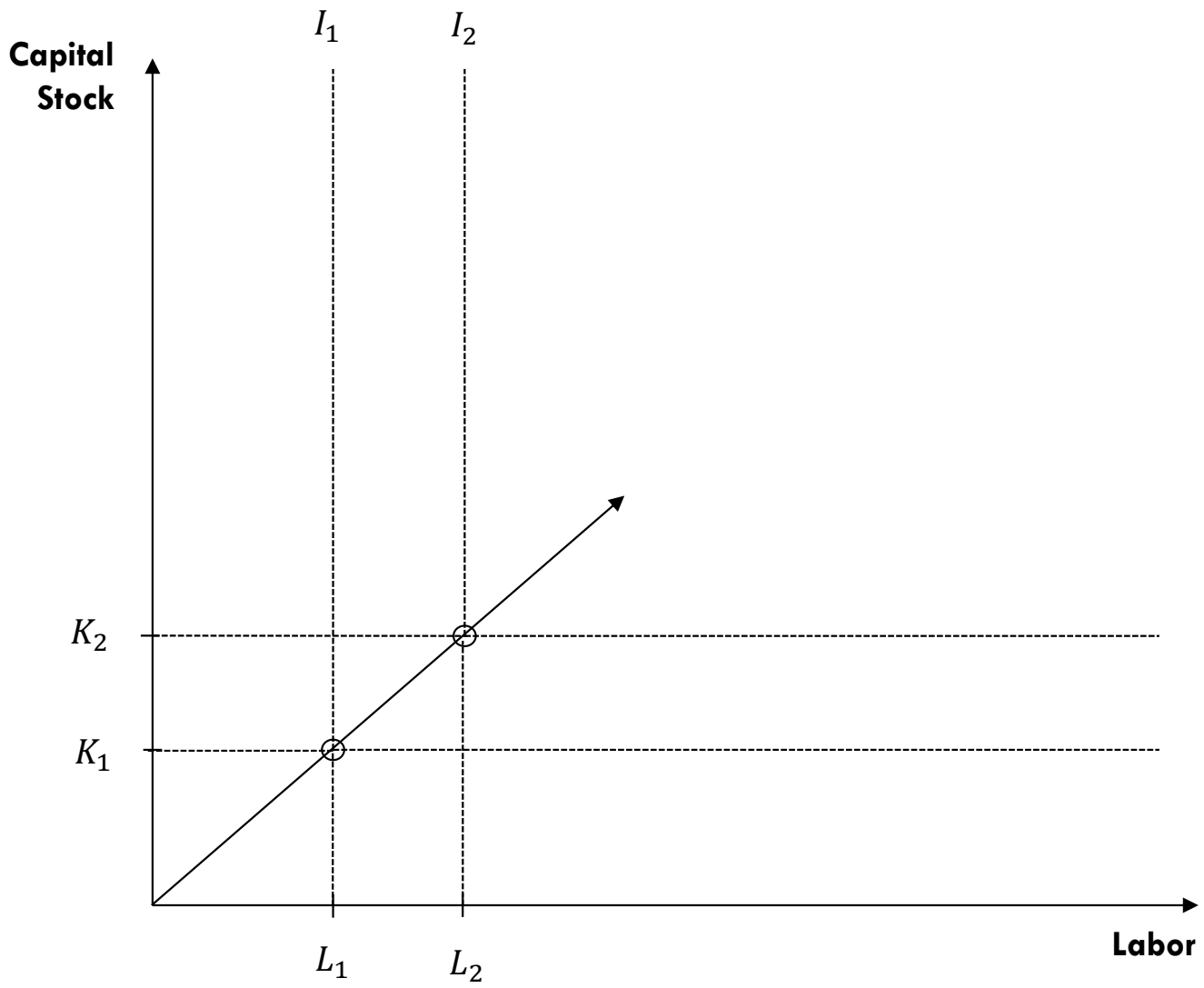


- **I_1 and I_2 are "isoquants": Combinations of inputs that produce equal amounts of output**
  - Indifference curves for producers
- **With this type of production, adding workers without increasing capital will result in no gains in production (and vice versa)**

What is v?

- **If we rearrange equation (1), then $v = \frac{K_c}{Y_c}$, this is known as the "capital-output ratio"**
  - This is a measure of the productivity of capital
  - Reflects the capital intensity of the production process (how much production depends on capital)
  - Varies across countries depending on technologies and products
    - Certain products are by their nature not capital intensive
  - Since v is a constant in the model, it means that $\frac{K_c}{Y_c}$ also needs to stay constant

Fixed Coefficient, Constant Return to Scale Production Function



- **What this means is let's say your at K_1 and L_1**
  - What is v here?
  - It's $\frac{K_1}{I_1}$
- **Let's say you increase capital to K_2, because $Y_c = \frac{K_c}{v}$, output goes up to something like I_2**
- **What had to happen to labor?**

Considering Growth Over Time

- **We can think of growth (change in Y) in production by adding a t subscript as follows:**

$$\Delta Y_c = Y_{c,t+1} - Y_{c,t} \tag{2}$$

- **By extending equation (1) we can say,**

$$\Delta Y_c = \frac{K_{c,t+1}}{v} - \frac{K_{c,t}}{v} = \frac{\Delta K_c}{v} \tag{3}$$

- **The growth rate, g, can be described as,**

$$g = \frac{\Delta Y_c}{Y_{c,t}} = \frac{\Delta K_c}{Y_{c,t} v} \tag{4}$$

Capital Over Time

- **Now, we need to make a statement over how capital changes over time**
- **There are two main forces that affect how capital changes over time**
  1. **Depreciation:** the rate at which capital falls apart and becomes unusable between time periods
     - Depreciation rate is modeled as $\delta \in (0,1)$
  2. **Investment:** the amount of production in the previous time period that is saved and added to the capital stock
     - Savings rate is modeled as $s \in (0,1)$

The Equation of Motion of Capital

- **We can use these parameters to make a statement for how capital evolves over time:**

$$\Delta K_c = K_{c,t+1} - K_{c,t} = \underbrace{sY_{c,t}}_{\text{Production saved and used as new capital}} - \underbrace{\delta K_{c,t}}_{\text{Amount of capital that falls into disrepair}} \quad (5)$$

Final Step of the Derivation

- **We can then substitute the equation of motion into equation (4) to see how the growth rate is affected by savings and depreciation,**

$$g = \frac{\Delta K_c}{Y_{c,t} v} = \frac{sY_{c,t} - \delta K_{c,t}}{Y_{c,t} v} = \frac{sY_{c,t}}{Y_{c,t} v} - \frac{\delta K_{c,t}}{Y_{c,t} v} \qquad (6)$$

$$\Longrightarrow \frac{sY_{c,t}}{Y_{c,t} v} - \frac{\delta K_{c,t}}{Y_{c,t} v} = \frac{s\cancel{Y_{c,t}}}{\cancel{Y_{c,t}} v} - \frac{\delta \cancel{Y_{c,t}} \cancel{v}}{\cancel{Y_{c,t}} \cancel{v}} = \frac{s}{v} - \delta \qquad (7)$$

Examining this Result

- **So this is the critical relationship,**

$$g = \frac{s}{v} - \delta \qquad (8)$$

- **How would changing the depreciation rate affect the growth rate?**
- **How would changing the savings rate affect the growth rate?**
- **How would changing the productivity of capital affect this?**
  - What does this last one mean? How would a country actually achieve this?

Implications

- **If you take this model literally it is saying:**
  - Growth is primarily located in the savings behavior affecting the growth of the capital stock and the productivity of capital
  - Even more simply: save more and make productive investments and you can expect growth
- **There is now end to growth as long the capital stock continues to grow (all else constant)**
  - Does this seem reasonable?

Weaknesses

- **Too focused on the capital stock**
  - What about technology?
- **Implies saving is *sufficient* for growth**
- **Assumes fixed relationships between capital, labor, and output**
  - In reality these things change at different rates over time
  - Results in a very inflexible model
- **While reasonably accurate predicting growth rates in the short term, it does poorly in the long term**

Why You Should Know It

- **Still influential: See Easterly (1999) for a good summary of its current uses**
  - https://documents1.worldbank.org/curated/en/494271468739201862/pdf/multi-page.pdf
- **Solow Model directly builds off of Harrod-Domar. That is where we are headed next**