NEOCLASSICAL GROWTH THEORY

I. *The Aggregate Production Function*

$Y = f(K, L, ...)$,

Properties:

- $f_K > 0$; $f_{KK} < 0$
- $f_L > 0$; $f_{LL} < 0$
- CRS $\Rightarrow f(\lambda K, \lambda L) = \lambda f(K, L)$
  - Let $\lambda = 1/L$, $k = K/L$, $y = Y/L$

    $\Rightarrow$ **$y = f(k, 1)$**

II. Growth Decomposition

Basic form: Y = A∗f(K, L), where A = "technical knowhow"

Note: Could add Land, Other Factors

1. **Totally differentiate** Y = A∗f(K, L)

$$dY = \frac{\partial Y}{\partial K} dK + \frac{\partial Y}{\partial L} dL + dA$$

$$\Rightarrow \hat{Y} = \frac{\partial Y}{\partial K} \cdot \frac{K}{Y} \cdot \hat{K} + \frac{\partial Y}{\partial L} \cdot \frac{L}{Y} \cdot \hat{L} \cdot dL + \frac{A}{Y} \cdot \hat{A}$$

2. Assume that **r = MPK** and **w=MPL** – i.e., perfect competition

$$\Rightarrow \hat{Y} = \underbrace{\frac{rK}{Y}}_{\text{Capital Share}} \cdot \hat{K} + \underbrace{\frac{wL}{Y}}_{\text{Labor Share}} \cdot \hat{L} + \underbrace{a}_{\text{"Residual"}} \Leftrightarrow \hat{Y} = \lambda_K \hat{K} + \lambda_L \hat{L} + a$$

<u>Points</u>

- Can decompose L,K (e.g., skilled/unskilled L; land, machines, etc.)
- Data on $\hat{Y}$, $\hat{L}(\hat{N})$ readily available.
- Data on capital stock less accessable, especially in LDC's, but investment data is usually available

  $\Rightarrow$ **substitute rI [= r(dK/Y)] for** $\frac{rK}{Y} \cdot \hat{K}$
- λ_L = total wages plus imputed wages of farmers
- λ_K = interest income and profits (incl. all property, land rental income)

III. *The Residual ("a")*

A. Initially thought as a measure of <u>exogenous technical change</u>

⇒ This is because it measures **TOTAL FACTOR PRODUCTIVITY**

⇒ Underpins **Growth Accounting** work of Denison, Solow

- Movement from a to b ⇒ TFP increase
- Holding input levels constant, TFP measures $\Delta Q = Q_1 - Q_0$
- In practice, two points are observed (a & c)

B. Broader Notion of the Residual (Harberger)

$$\Delta Y = \sum_i \Delta L_i (w_i + D_i) + \sum_j \Delta K_j (r_j + D_j) + a$$

Residual now though of as a composite of the effects of many forces:

1. Improvement in the **quality of labor.**

2. Reallocation of resources from low-productivity to high-productivity uses ⇔ **allocative efficiency**

- Via normal market forces (move onto the frontier) and/or
- Via reduction of structural barriers/distortions

3. Exploitation of **economies of scale**

4. **Technique** (!) = ways of combining resources

⇒ **THE RESIDUAL IS THE SUM OF WHAT WE DON'T KNOW AND/OR CAN'T EXPLAIN**

C. Introduction of Human Capital (Mankiw, Weill, & Romer)

Cobb-Douglas prod. function: $Y = AK^{\alpha}L^{1-\alpha}$

$\Rightarrow \alpha = rK/Y = \lambda_K$, $1-\alpha = wL/Y = \lambda_L$

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Problem: Derive the fact that $\alpha = rK/Y$, $1-\alpha = wL/Y$
Hint: Max Output (Y) minus cost ($rK + wL$)
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- Given plausible, generally accepted measures of relative α's, L's, and Y's for various counties, these imply **unbelievably large capital stocks** (or big differences in the residual "a")

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U.S./Philippine Example:

$\alpha = .4$, $1-\alpha = .6$, $Y_{US} = 110Y_{PH}$; $L_{US} = 3.67L_{PH}$

$$Y_{US} = 110 \cdot A \cdot L_{PH}^{.6} \cdot K_{PH}^{.4} = A \cdot (3.67)^{.6} \cdot L_{PH}^{.6} + X^{.4} \cdot K_{PH}^{.4}$$

$$\Rightarrow \quad \frac{110}{(3.67)^{.6}} = X^{.4}$$

$\Rightarrow K_{US} = 18{,}050\ K_{PH}$ **but in fact $K_{US} \approx 92 * K_{Ph}$**

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- However, breaking K into K and H (human capital) seems to greatly improve the "calibration" of the Cobb-Douglas to known parameters.

- H explains 80% of variation between developed and developing countries.

IV. Critique

Key assumptions that might be **questionable** in LDC's are:

1. Perfectly competitive markets
2. Exogenous technological change within a given country
3. Common technology across countries/economies

CONVERGENCE

I. The Aggregate Production Function (again)

$Y = f(K, L, ...)$,

Properties:

- $f_K > 0$; $f_{KK} < 0$
- $f_L > 0$; $f_{LL} < 0$
- CRS $\Rightarrow f(\lambda K, \lambda L) = \lambda f(K, L)$
  - Let $\lambda = 1/L$, $k = K/L$, $y = Y/L$

  $\Rightarrow$ **y = f(k, 1) : This is the "intensive form" of the prod f'n**

Assuming a constant savings rate (s), constant population growth (n) and a depreciation rate δ:

$$\dot{K} = \frac{dK}{dt} = sLf(k) - \delta K \quad \Leftrightarrow \quad \frac{\dot{K}}{L} = sf(k) - \delta k$$

$$\left[\textbf{Use :} \quad \dot{k} = \frac{dk}{dt} = \frac{d\left(\frac{K}{L}\right)}{dt} = \frac{L\dot{K} - K\dot{L}}{L^2} = \frac{\dot{K}}{L} - k\frac{\dot{L}}{L} = \frac{\dot{K}}{L} - kn \right]$$

$\Rightarrow$ (w/ algebra) **Fundamental Insight of the Solow Model:**

$$\hat{k} = \frac{\dot{k}}{k} = \frac{sf(k)}{k} - n - \delta$$

Steady State Condition: $\hat{k} = 0 \quad \Rightarrow \quad \frac{sf(k)}{k} = n + \delta$

II. *Dynamics of Moving to a Steady State*

Steady State Condition: $\hat{k} = 0 \Rightarrow \frac{sf(k)}{k} = n + \delta$

To the left of k*, sf(k)/k lies above n + δ

⇒ the growth rate of the capital stock is positive and k rises over time.

⇒ **This growth rate declines over time (as k → k*) – an "artifact" of the math/underlying assumptions**

⇒ **It can also be shown that when $\hat{k} > 0$, then $\hat{y} > 0$**

Heuristic Explanation:

When k = K/L is relatively low, the marginal product of capital is relatively high (as is the average product of capital, f(k)/k).

Since s is a constant, sf(k)/k is also relatively large compared to n + δ.

III. *Absolute Convergence*

- Assumes **structurally similar economies** with comparable values of s, n, and δ
- Only difference between economies is difference in starting values of capital per person (k_0)

$\Rightarrow$ **same steady state values of k*, y* for all economies**

Empirical Verification

- S**ome support for developed countries** (e.g., OECD), states of the U.S.
- **No support for LDC's**, but this is hardly surprising given the strong assumptions regarding equal values of s and n.
- Handout/discuss Barro graphs/scatter plots

IV. *Conditional Convergence*

- **Allows for heterogeneity across economies anything that cause cross-sectional variation in the position and shape of the prod. function – e.g. differences in s, n, δ, education, etc.**

- **Main idea is that an economy grows faster the further it is from its own particular steady state.**

- This is much more reasonable, more in the spirit of the underlying neo-classical model (according to Solow)

Here economies differ in:

1. initial capital stock – ($k_{poor} < k_{rich}$); and
2. savings rates – ($s_{poor} < s_{rich}$)

Barro also uses a sine-wave looking graph to tell stories about low-level equilibrium traps:

This story is ad hoc, to say the least.

Points:

1. Changing s, n, or δ change the location of k^* but not the steady state growth rates of k, y, or c (all = zero!)

2. These are parameters that may be amenable to policy intervention.

3. Continuous (exogenous) technical change will lead to a steady state growth rate > 0 and equal to the rate of technical change. **Steady technical change amounts to a continuous shift of the production function ⇒ shifts savings curve to the right.**

- This can be used to explain (a) persistent long-run growth; and (b) differences between LDC growth and DC growth.

- But where does this tech. change come from?

IV. *Empirical Evidence (Levine & Renelt)*

Motivation:

Test the robustness of empirical findings regarding the conditioning variables in conditional convergence using a couple of big data sets for the period 1960-1989.

Method:

1. Start with the basic regression model:

$$\hat{y} = \alpha + \beta_1 y_0 + \beta_2 \frac{I}{Y} + \beta_3 n + \beta_4 Ed, \quad \text{where } \beta_1, \beta_3 < 0 < \beta_2, \beta_4$$

2. Append three additional conditioning variables selected from a pool of 7:

Gov/Y; Exports/Y; π, Credit growth (C); σ_π, σ_C; # of revs,coups
FISCAL TRADE MONETARY POLICY RISK POLITICS

$\Rightarrow$ These are representative of the kinds of fiscal, trade, monetary, uncertainty, and political variables typically used in empirical studies of convergence

Findings:

1. Only I/Y, Exports/Y, and Y_0 have robust, significant effect on $\hat{y}$.

2. Other conditioning variables are not robust – significance levels fragile w.r.t. different combinations of indep. variables.

   $\Rightarrow$"Very difficult to isolate a strong empirical relationship between any particular macro policy indicator and long-run growth."

3. Support for conditional convergence over the entire 1960-1989 period, but not for the 1974-1989 period.

NEW GROWTH THEORY

I. IMPULSES TO RETHINKING THE STANDARD MODEL

1. Non-convergence and Different Long-run Growth Rates

- While some LDC's have been catching up (e.g., S.E. Asia), others have not (e.g., Africa)

- Even among DC's, convergence appears to have been a pheonomenon of the post WWII years

- There was a Neo-classical counter-revolution by Barro; Mankiw, et al.; others

- Lucas: "If capital is mobile, then why are laborers with high levels of Human Capital migrating from areas where it is scarce to areas where it is abundant?" ...

➢ **This led directly to work by Lucas and Romer (his student) that launched the New Growth "revolution"**

2. **Endogenous Technical Change**

- Romer noted that the growth rate of richer countries has been **increasing** over time.

- This can only happen in the neo-classical model when exogenous technical progress accelerates.

Outcome

- Models were developed that tried to explain why technical change might occur at different rates.
  - Primary adaptation was to make technology ("A") a function of the capital stock ... A = A(K).
  - In particular, models focused on how "success breeds success" (or **Learning by Doing**) so that technology leaders might maintain or expand their relative advantage
  - These models focused on hu**man capital and "knowledge"**
  - Another vein here is the **spillover effects of R&D** (esp. publicly financed R&D and international spillovers)

3. Abandoning Perfect Competition

- **Increasing returns to scale** (esp. for capital linked to knowledge)

  $\Rightarrow$ **MPK > r** $\rightarrow$ rents to capital accumulation

  $\Rightarrow$ **Larger steady state values of K/L** than neo-classical model predicts

  $\Rightarrow$ This approach was facilitated by improvements in the ability to model imperfect competition (notably **Stiglitz-Dixit model** of monopolistic competition)

- Imperfect competition relates back to the endogenous technical change work by providing an **underlying reason why spillovers might exist**

  - Each firm might be lucky enough to have access to monopoly rents (from superior technical knowledge) and this is enough of an incentive to guarantee that some firms will successfully innovate

II. NEOCLASSICAL VS. NEW GROWTH MODELS

Romer's 5 facts:

1. **Many firms** in the economy
2. Information-based **discoveries are non-rival**
3. Physical **production is replicable** – i.e., characterized by CRS
4. Technological change results from (non-random) human activity
5. Many firms/agents hold market power and collect **monopoly rents on discoveries**

Characterizing the variants:

- **Neoclassical model** captured facts 1, 2, and 3.
- **Endogenous tech. change** new-growth models included fact 4 (sometimes in violation of fact 2)
- **Increasing returns** new-growth models included fact 5 (sometimes in violation of fact 3).

III. IMPLICATIONS OF NEW GROWTH THEORY FOR LDC'S

1. Departure from the convergence paradigm

- Convergence no longer a necessary/inevitable outcome
- Corollary is that there may be a role for some form of policy/government intervention

2. Greater emphasis on human capital development

- Knowledge, exchange/use of ideas emerges as a critical element of aggregate growth $\Rightarrow$ potentially important role for policy

3. Governments can better stimulate growth via better targeting

- Identify increasing returns industries (i.e., knowledge-producing and human capital-intensive sectors)
- Provide incentives to firms in those sectors
- In other words, return to the kind of **strategic complementarity** and **targeted growth** approach that characterized the Big Push
  - But, it's still very difficult to identify the key sectors, and to coordinate and implement productive policies.
  - Also, still need appropriate institutional underpinnings to make it work.

4. Outward orientation can help facilitate exploiting knowledge spillovers

- Avoid duplication of expensive R&D
- Not inevitably helpful to LDC's though

STRUCTURALISM

I. BASIC IDEA

1. **Identify major features** of resource mobilization and allocation that lead to economic growth.

2. Identify systematic differences across countries

⇒ **Typologies of Development** that speak to the impacts of different development strategies.

3. Processes tend to follow an **S-shaped pattern**

⇒ Slow change at low and high incomes, relatively rapid growth in the middle.

⇒ Led to semi-log form in the empirical analysis

4. **Big Caveat:**

"The most that can be claimed is that (the statistical analysis) is helpful in diagnosing structural problems of a given country and in outlining/suggesting feasible growth patterns."

⇒ This work is not useful for detailing policy prescriptions.

5. **Key Innovation:**

Replaced the notion of a dichotomy between LDC's and DC's with the concept of development as a transition from one state to another.

II. METHODOLOGY

- Regression analysis of the following form:

$X = \alpha + \beta_1 \ln Y + \beta_2 (\ln Y)^2 + \beta_3 N + \beta_4 N^2 + \text{Time Trend}$

- Cross-sectional, time-series data and analysis

- Big study (1975 book): 1950-1970, 101 countries
  Updated study (1989 paper): 1950 – 1983, 108 countries.

- **Table 3:**

For each characteristic (X), compute X at different levels of annual per capita income (<$300, $300, $500, $1000, $2000, $4000, >$4000), and assuming N = 20,000,000.

III. CHARACTERISTICS ANALYZED

1. **Investment**: I, S, Net Imports
2. **Government rev**: Total, taxes
3. **Education:** Expenditure, Enrollment
4. **Demand Structure:** C, I and G shares; Food Share
5. **Prod'n Structure**: Primary, Industry, Services, Utilities
6. **Trade Structure:** Exports (manu, primary, serv.), Imports
7. **Labor Allocation:** By sector (primary, industrial, service)
8. **Urbanization:** % of population in cities
9. **Demographic:** Birth Rate, Death Rate
10. **Income Distrib:** Top 20%, Bottom 40%

For each characteristic, Chenery and Syrquin investigate:

1. Correlation of changes of characteristic with $\hat{Y}$.
2. Range of income over which change in characteristic is largest.
3. Effect of non-income variables.
4. Sources of differences in development patterns.

IV. BASIC RESULTS FROM TABLE 3: PATTERNS AS Y GROWS

1. **Final Demand:** Consumption falls, Investment rises (consistent w/ neoclassical theory)

2. **Food consumption** declines (consistent w/ Engel's Law)

3. **Trade:**

- Primary exports tend to decline, Manu. tends to increase
- Little change in imports composition
- Signif diffs across countries, depending sometimes on strength of Import Substitution strategies.

4. **Production:** Ag falls dramatically, Manu. & Services rise strongly

5. **Labor force:** Same as for Production–Ag ↓, Manu. & Services ↑

V. PERFORMANCE OF DIFFERENT TYPES OF ECONOMIES

A. Stratifications

1. **Large vs. small** – based on 1965 population.
2. **Primary vs. Manufactured Exporters** – relative to average.
3. **Outward vs. Inward** – relative to average of Exports/GDP for all countries

B. Growth by Typology (Table 8)

	Large		Small		All	
Group	**No.**	**$\hat{Y}$**	**No.**	**$\hat{Y}$**	**No.**	**$\hat{Y}$**
Primary	15	5.00%	50	4.24%	65	4.42%
-Inward	10	4.94%	27	3.58%		
-Outw'd	5	5.12%	23	5.01%		
Manuf.	14	5.04%	27	5.11%	41	5.05%
-Inward	6	4.73%	17	4.74%		
-Outw'd	8	5.26%	10	5.73%		
Inward (total)						4.28%
Outward (total)						5.22%

C. Key Findings

1. Significant positive relationship between **outward orientation** and growth
2. **Manufacturing** specialized countries tend to **outperform primary** specialized ones
3. Larger countries tend to outperform smaller countries.

- Small countries are more specialized, more subject to the **"commodity lottery"**

VI. STRUCTURALIST VS. NEOCLASSICAL APPROACHES

Neoclassical: Assumes efficient allocation of resources

⇒ Reallocation of capital and labor takes place as economy expands

⇒ Assumes **equilibrium** always holds

Structuralist: Assumes some resources not fully utilized

⇒ May be systematic differences in returns to specific factors

⇒ Assumes **disequilibria** occur

⇒ Structural barriers to factor mobility

Sources of disequilibrium in the structural approach

1. **Dualism in labor market**

- Elastic supply of labor, especially concentrated in the agriculture and service sectors.

2. **Balance of payments deficits due to**

- Excess import demand.
- Distorted incentives to producers to enter new markets.
- Import substitution policies.

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WHEN EQUILIBRIUM IS NOT AXIOMATIC, THEN THE QUESTION OF HOW MUCH RE-ALLOCATION OF RESOURCES FROM ONE SECTOR TO ANOTHER OCCURS IS AN EMPIRICAL QUESTION

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Comparison Analysis of the Two Approaches (Meier, pp. 95-99)

Chenery regressed $\hat{Y}$ on 3 neoclassical and 4 structural variables:

Neoclassical	Structural
I/Y – proxy for $\hat{K}$	Ag. share – shift from ag to ind.
$\hat{N}$ – proxy for $\hat{L}$	Export Share
Ed. – proxy for L quality	Balance of Payments deficit
	Level of development (?)

Findings

1. Growth of capital important, but less so when structural variables are included.

$\Rightarrow$ **Capital growth captures the effects of other variables** (in part)

2. Labor growth less significant (not significant sometimes) when structural variables included.

$\Rightarrow$ Consistent with **labor dualism**

3. **Reallocation of labor from ag. to other sectors accounts for 20% of $\hat{Y}$**

4. **Export growth was an important contributor to $\hat{Y}$ after 1964.**