

Lecture 4: Technological Progress and a Unified Model of Development

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“... in a number of important historical instances industrialization processes, when launched at length in a backward country, showed considerable differences with more advanced countries, not only with regard to the speed of development (the rate of industrial growth) but also with regards to the productive and organizational structures of industry... these differences in the speed and character of industrial development were to a considerable extent the result of application of institutional instruments for which there was little or no counterpart in an established industrial country.”
Gerschenkron (Economic Backwardness in Historical Perspective, p. 7)

Technological Progress in LDC

- There is a positive relationship between R&D intensity and distance from technological frontiers measured as

$$\frac{TFP_{i,c,t}}{\widehat{TFP}_{i,t}}$$

Table 1
Innovation and distance to frontier

	(1)	(2)	(3)	(4)	(5)	(6)
	no correction for diff. in skills and hours			correction for diff. in skills and hours		
Distance to frontier	0,031 (0,006)	0,018 (0,004)	0,009 (0,004)	0,034 (0,006)	0,018 (0,004)	0,008 (0,003)
Year dummies	YES	YES	YES	YES	YES	YES
Country dummies	NO	YES	YES	NO	YES	YES
Industry dummies	NO	YES	YES	NO	YES	YES
Country-industry dummies	NO	NO	YES	NO	NO	YES
Number of Observations	1801	1801	1801	1801	1801	1801

Standard errors are in parentheses. The dependent variable is the ratio of R&D over value added at the 2/3 digit level. The independent variable "Distance to frontier" is the inverse of TFP in each industry relative to frontier (see Griffith, Redding, Van Reenen (2002)) and is defined as decreasing in the distance to frontier. The mean of the dependent variable is 0.033 and its standard deviation is 0.045. The mean of the independent variable is 0.729 (0.705 in columns 4-5-6) and its standard deviation is 0.196 (0.203 in column 4-5-6).

Technological Progress in LDC

The Model

- Production

$$Y(t) = \frac{1}{\alpha} N(t)^{1-\alpha} \int_0^1 A(v, t)^{1-\alpha} x(v, t)^\alpha dv$$

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$$p(v, t) = \chi > 1$$

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- The final good sector is competitive

Technological Progress in LDC

Analysis

- Monopolists face the following demand by final good producers

$$p(v, t) = (A(v, t)N(t)/x(v, t))^{1-\alpha}$$

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- $\delta'(\chi) > 0$: The higher the monopolistic power the higher the profits

Technological Progress in LDC

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- Word Technological Frontier

$$\bar{A}(t) = (1 + g)\bar{A}(t - 1)$$

Technological Progress in LDC

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- World Technological Frontier

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- Frontier in the LDC

$$A(t) = \eta\bar{A}(t - 1) + \gamma A(t - 1)$$

Technological Progress in LDC

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$$a(t) = \frac{A(t)}{\bar{A}(t)} = \frac{1}{1 + g}(\eta + \gamma a(t - 1))$$

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- Catching up if $\gamma < 1 + g$.

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Innovation Strategies

- Old entrepreneurs, high $\eta = \bar{\eta}$ and low $\gamma = \underline{\gamma}$

Technological Progress in LDC

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- Strategies

$$a(t) = \begin{cases} \frac{1}{1+g}(\bar{\eta} + \underline{\gamma}a(t-1)) & R = 1 \\ \frac{1}{1+g}(\underline{\eta} + \bar{\gamma}a(t-1)) & R = 0 \end{cases}$$

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- $R = 1$ is based on long term contracts between credit market and entrepreneurs
- $R = 0$ short term contracts

Technological Progress in LDC

Optimal Pattern of Innovation

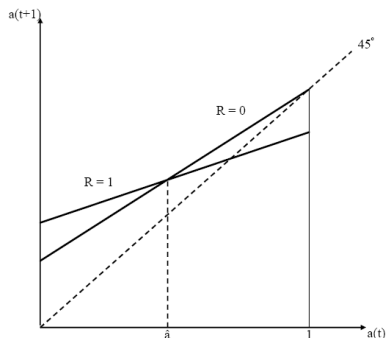


FIGURE 21.4. The growth-maximizing threshold and the dynamics of the distance to frontier in the growth-maximizing equilibrium.

- In general entrepreneurs choose $a_r(\delta) \neq \hat{a}$

Technological Progress in LDC

Implementation of Innovation Strategies

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Technological Progress in LDC

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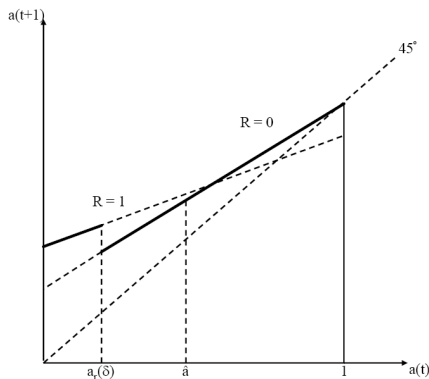
Technological Progress in LDC

Implementation of Innovation Strategies

- Imperfection in Credit market ban young entrepreneurs
- Old entrepreneurs can leverage their profits if χ is large
- $R = 1$ is more likely if χ is large (i.e. there is a Switching point, $a_r(\delta)$, with $a_r'(\delta) > 0$)

Technological Progress in LDC

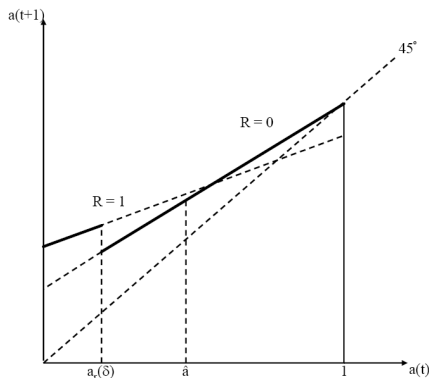
Underinvestment equilibrium



- $a_r(\delta) < \hat{a}$: Appropriability problem may lead old entrepreneurs to underinvest

Technological Progress in LDC

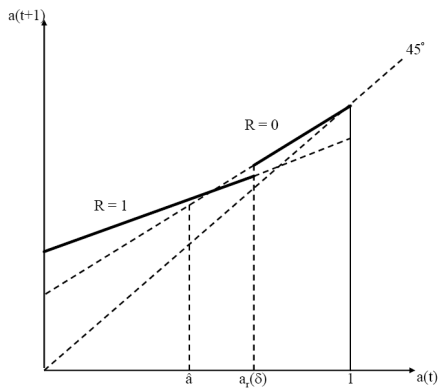
Underinvestment equilibrium



- $a_r(\delta) < \hat{a}$: Appropriability problem may lead old entrepreneurs to underinvest
- $\delta(\chi)$ low: Market too competitive!

Technological Progress in LDC

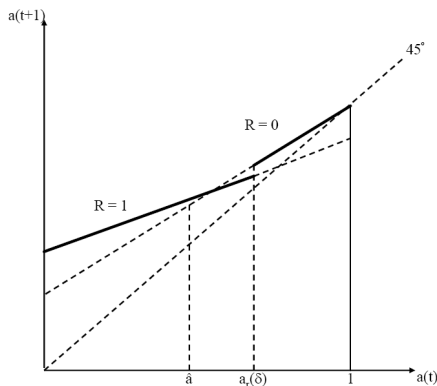
Sclerotic Equilibrium



- $a_r(\delta) > \hat{a}$: too little competition

Technological Progress in LDC

Sclerotic Equilibrium



- $a_r(\delta) > \hat{a}$: too little competition
- The retained earnings of incumbent entrepreneurs act as a shield against the creative destruction by new entrepreneurs

Technological Progress in LDC

Poverty Trap equilibrium

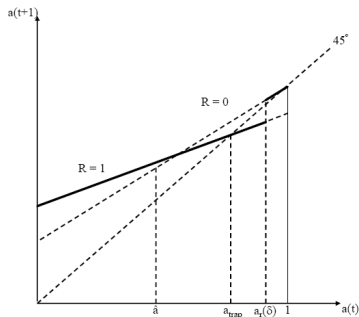


FIGURE 21.7. Dynamics of the distance to frontier in a non-convergence trap. If the economy starts with $a(0) < a_{trap}$, it fails to converge to the world technology frontier and instead converges to a_{trap} .

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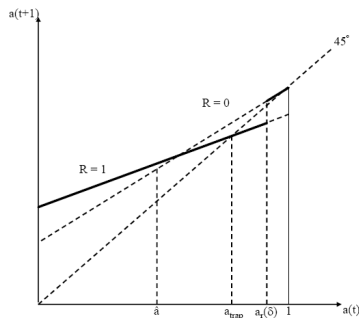


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- Entrepreneurs bribe political institution to block innovations (push χ too high).

Technological Progress in LDC

Empirical Evidence

- Distance to Frontiers = $\frac{y_{i,65}}{y_{US,65}}$

OLS

Panel A: Dep. variable is growth rate

High barriers (main effect)	0,040 (0,009)	0,039 (0,005)	0,021 (0,009)
Low barriers (main effect)	0,036 (0,008)	0,029 (0,005)	0,011 (0,009)
Distance to frontier * high barriers	-0,078 (0,028)	-0,062 (0,013)	-0,072 (0,016)
Distance to frontier * low barriers	-0,028 (0,029)	0,009 (0,017)	-0,018 (0,025)

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- This might be efficient to some extent
- Given credit market imperfections the market may fail to generate an optimal strategy of innovation
- Monopolistic power and institutional arrangements can be a substitute for credit market imperfection
- But it can also generate a poverty trap.

Multiple Equilibria From Aggregate Demand Externalities

Murphy, Shleifer and Vishny (1989)

- Due to fix cost in production, each firm industrializes only if demand is high

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- Therefore Coordination problem (big push needed)
- Unrealistic (one shot) description of industrialization

A Unified Model of Growth and Development?

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 - ③ Changing fertility rates and the demographic transition (Galor and Weil)
 - ④ Adaptations of markets for innovation (Acemoglu-Aghion-Zilibotti)
- Is there a need of a unified model taking into account economic *and* social variables?

A Unified Model of Growth and Development?

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- Solow Equation

$$\dot{k}(t) = sf(k(t), x(t)) - \delta k(t)$$

A Unified Model of Growth and Development?

A pure "Marxian" Economy

- Assume to begin with, $f_x = 0$

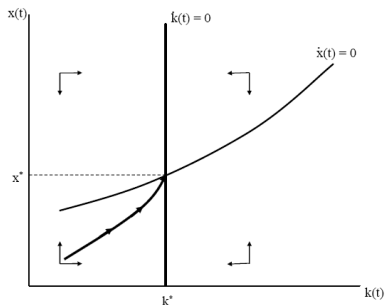


FIGURE 21.10. Capital accumulation and structural transformation without any effect of the "social variable" x on productivity.

A Unified Model of Growth and Development?

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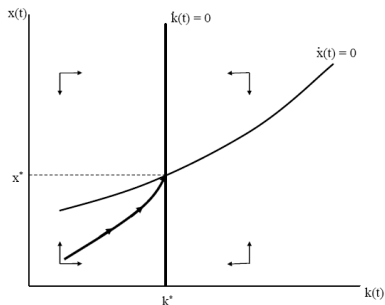


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- Unique stable Equilibrium

A Unified Model of Growth and Development?

- Case $f_x > 0$ (i.e. effect of x small)

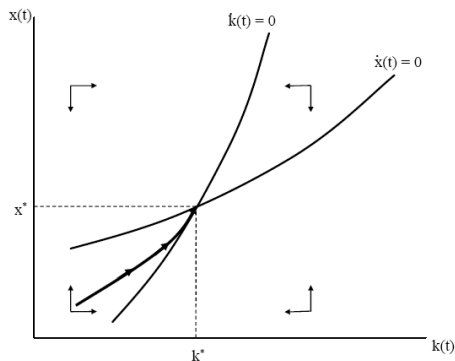


FIGURE 21.12. Capital accumulation and structural transformation when the “social variable” x affects but there exists a unique steady state.

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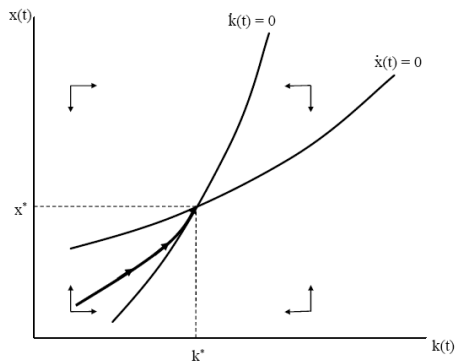


FIGURE 21.12. Capital accumulation and structural transformation when the “social variable” x affects but there exists a unique steady state.

- The two effect are cumulative

A Unified Model of Growth and Development? (cont'd)

- Case $f_x \gg 0$ (i.e. effect of x large)

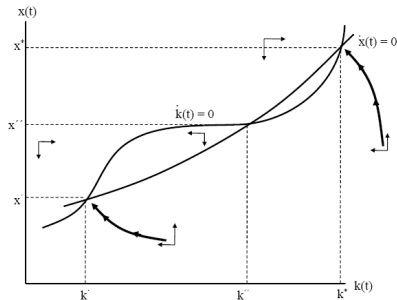


FIGURE 21.11. Capital accumulation and structural transformation with multiple steady states.

A Unified Model of Growth and Development? (cont'd)

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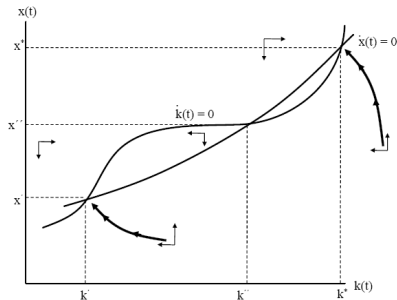


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- Multiple steady state and path dependence