Lecture 4: Technological Progress and a Unified Model of Development

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Technological Progress in LDC

"... 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)

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- 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	0,018	0,009	0,034	0,018	0,008
	(0,006)	(0,004)	(0,004)	(0,006)	(0,004)	(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).

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The Model

- Production

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

  - $A(v,.)$ technology machine v, $x(v,.)$ amount of this machine used
  - Producing a new machine has a cost 1.
- Producer is a monopolist with a price

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

- The final good sector is competitive

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Analysis

- Monopolists face the following demand by final good producers

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

- Given the monopolistic power of intermediates

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

- So that the intermediates' profit is

$$\pi(v,t) = (p(t,v)-1)x(v,t) = \delta(\chi)A(v,t)N(t)$$

with $\delta(\chi) \equiv (\chi - 1)\chi^{-\frac{1}{1-\alpha}}$,

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

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Analysis

- Word Technological Frontier

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

- Frontier in the LDC

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

- Distance from frontier

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

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

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Innovation Strategies

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

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

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

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Optimal Pattern of Innovation

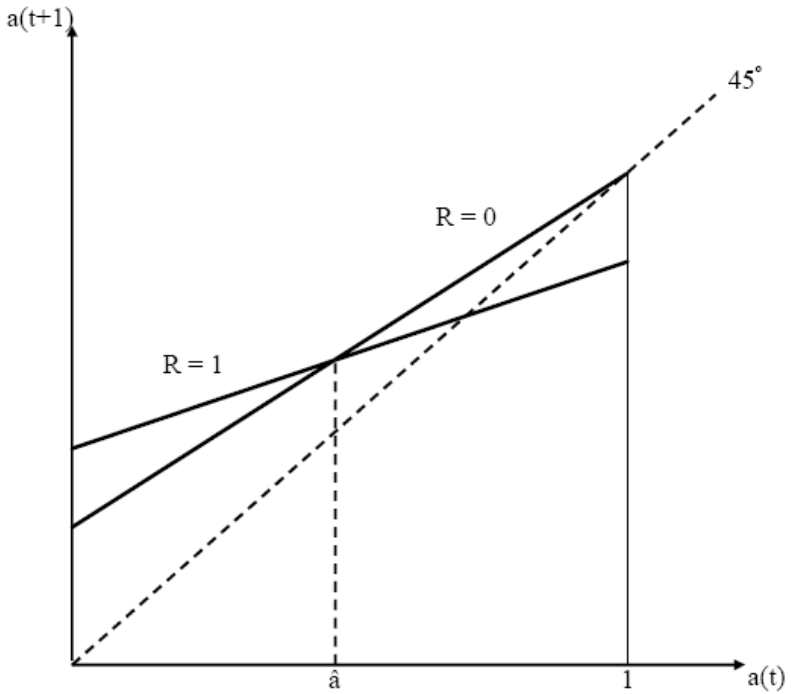

FIGURE 21.4. The growth-maximizing threshold and the dynamics of the distance to frontier in the growth-maximizing equilibrium.

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

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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 $a_r'(\delta) > 0$)

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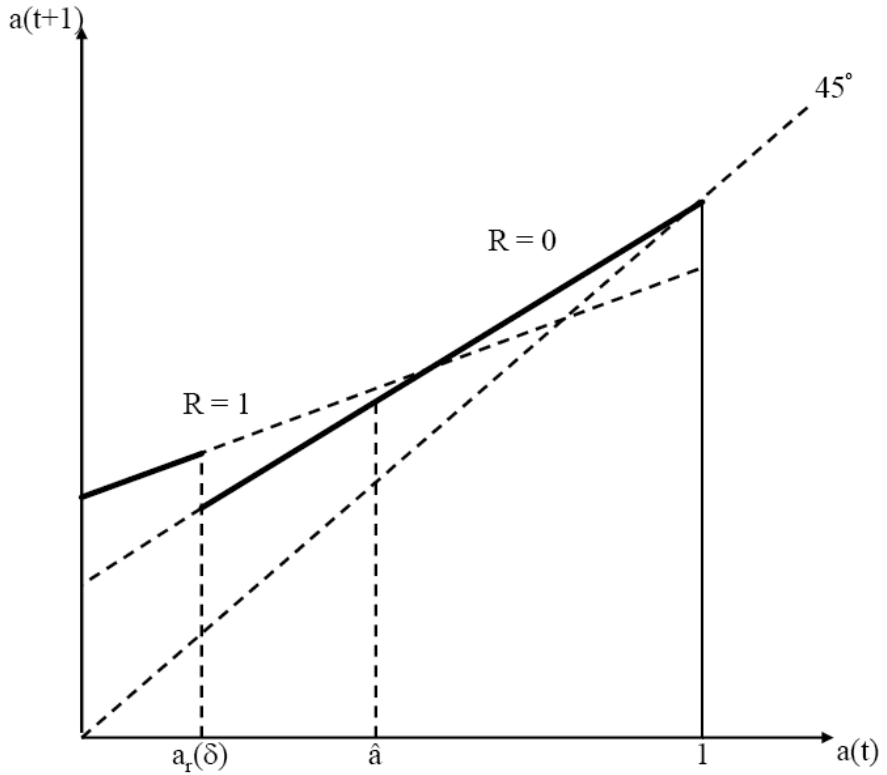
Underinvestment equilibrium



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

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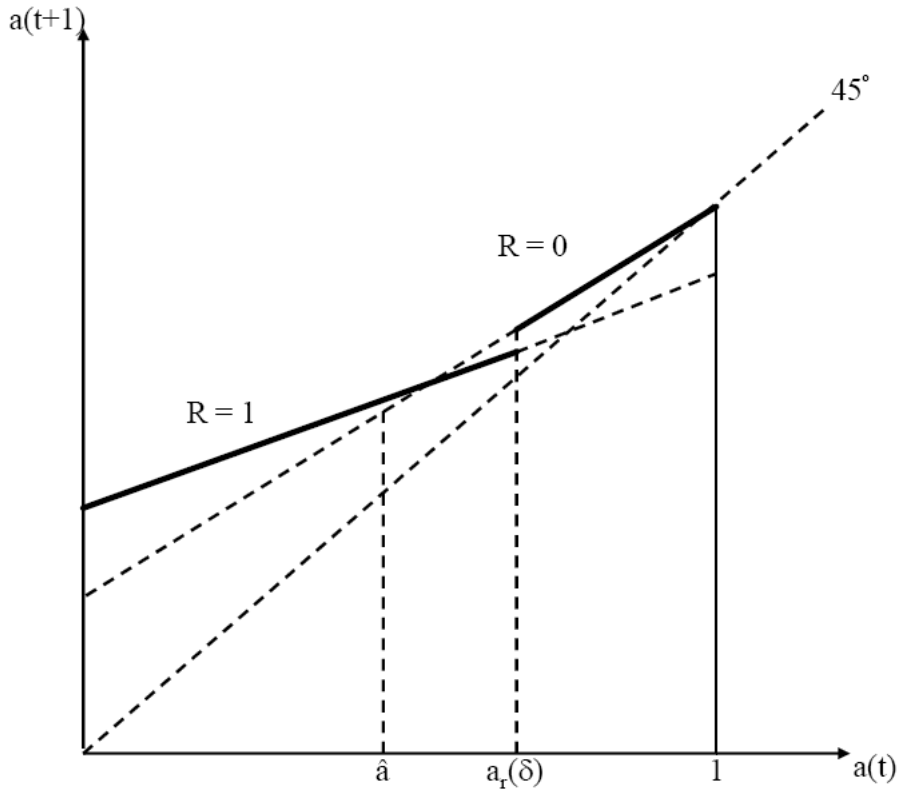
Sclerotic Equilibrium



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

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Poverty Trap equilibrium

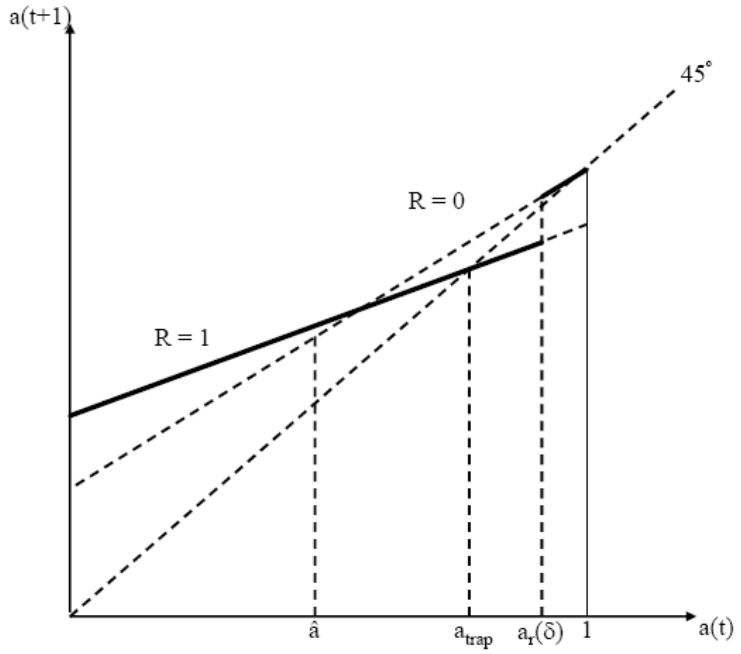

FIGURE 21.7. Dynamics of the distance to frontier in a non-convergence trap. If the economy starts with $a(0) < a_{trap}$, it fails to converge to the world technology frontier and instead converges to a_{trap}.

- Far too little competition: $\delta(\chi)$ is very high, i.e. monopolist makes huge profit from imitating
- Entrepreneurs bribe political institution to block innovations (push χ too high).

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Empirical Evidence

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

	OLS		
	Panel A: Dep. variable is growth r		
High barriers (main effect)	0,040	0,039	0,021
	(0,009)	(0,005)	(0,009)
Low barriers (main effect)	0,036	0,029	0,011
	(0,008)	(0,005)	(0,009)
Distance to frontier * high barriers	-0,078	-0,062	-0,072
	(0,028)	(0,013)	(0,016)
Distance to frontier * low barriers	-0,028	0,009	-0,018
	(0,029)	(0,017)	(0,025)

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Final Remarks

- There is evidence that LDC imitate and adopt existing innovations rather than create new ones
- 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
- The demand is high only if profit and wages are high
- Profit and wages are high only if all firms industrialize
- Therefore Coordination problem (big push needed)
- Unrealistic (one shot) description of industrialization

A Unified Model of Growth and Development?

Issues

- The Models studied have emphasized the transformation of the economy *and* the society over the process of development
- This transformation takes the form of:
  1. the structure of production changing (Matsuyama and Agemoglu-Guerrieri)
  2. financial markets becoming more developed (Towsend, Greenwod Jovanovic, Galor and Zeira)
  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?

- Consider a continuous time economy

$$y(t) = f(k(t), x(t))$$

  - $k(t)$: capital per worker ratio (proxy for development)
  - $x(t)$ a social variable (i.e. market imperfection, urbanization, institutions...)
  - $f_x > 0$
- Assume that

$$\dot{x}(t) = g(k(t), x(t))$$

  - With $g_k > 0$
  - $g_x < 0$ reversion to natural level argument
- 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, $f_x = 0$

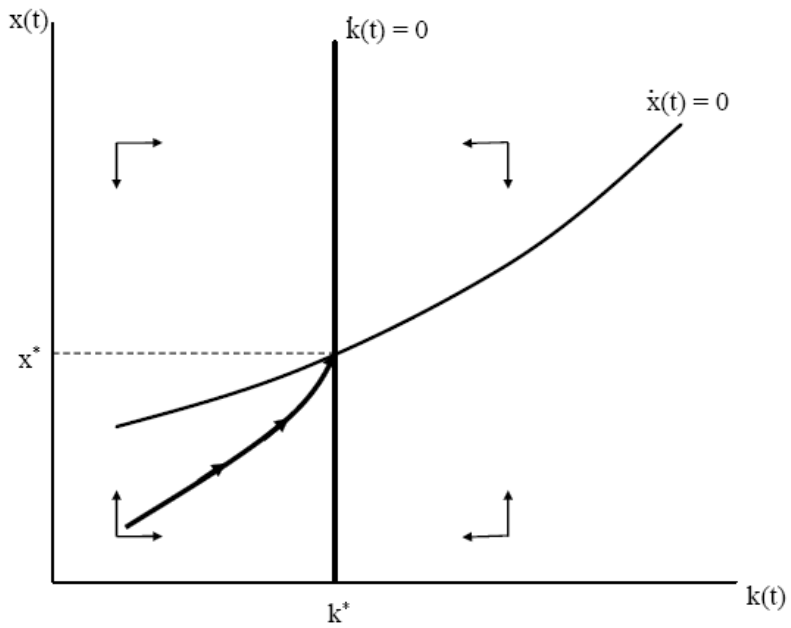

FIGURE 21.10. Capital accumulation and structural transformation without any effect of the "social variable" x on productivity.

- Unique stable Equilibrium

A Unified Model of Growth and Development?

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

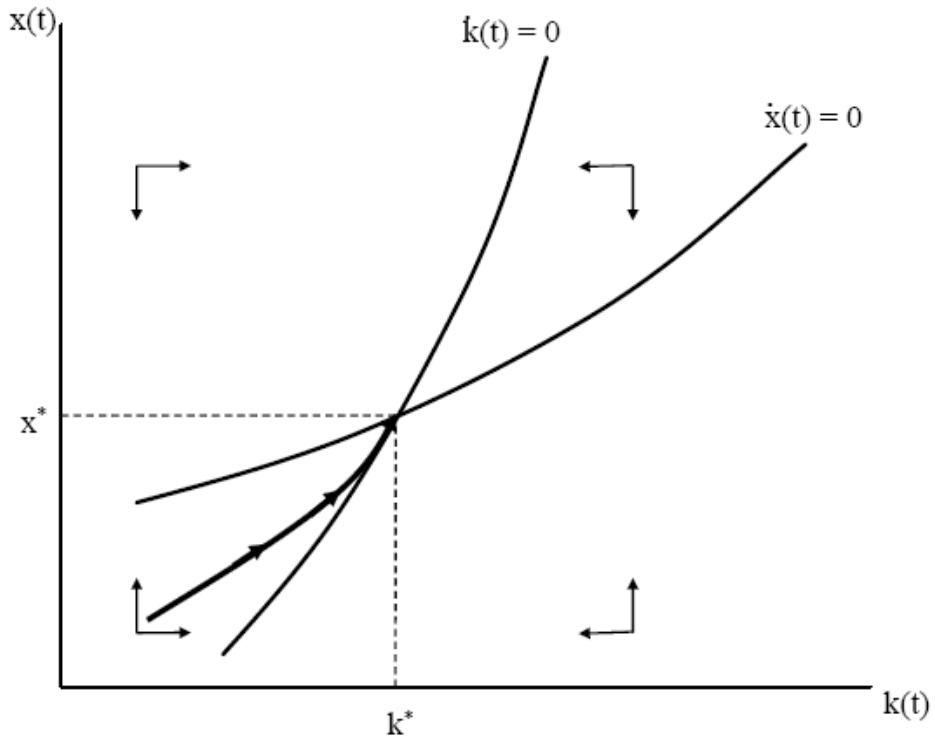

FIGURE 21.12. Capital accumulation and structural transformation when the "social variable" x affects but there exists a unique steady state.

- The two effect are cumulative

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

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

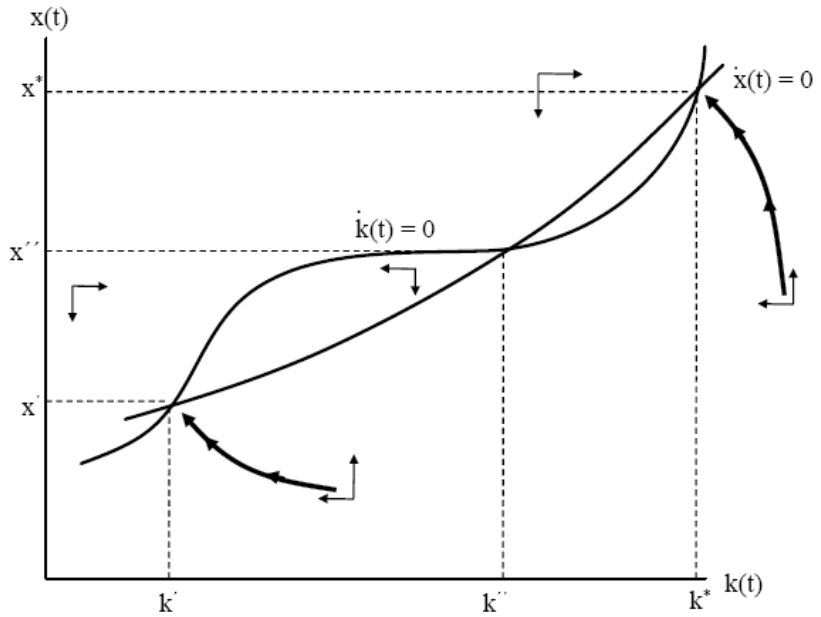

FIGURE 21.11. Capital accumulation and structural transformation with multiple steady states.

- Multiple steady state and path dependence