Economic Growth: Growth Education and Human Capital

EC307 Economic Development

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Lecture 3

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READINGS

Chapters 5 of Ray (1998)

Duflo, E. (2001). Schooling and Labor Market Consequences of School Construction in Indonesia: Evidence from an Unusual Policy Experiment. *American Economic Review*, 91(4):795–813.

Galor, O. and Zeira, J. (1993). Income Distribution and Macroeconomics. *Review of Economic Studies*, 60(1):35–52.

Lucas Jr, R.E. (1993). Making a Miracle. *Econometrica*, 61(2):251–272.

- **Class based on** Mankiw, N.G., Romer, D. and Weil, D. (1992). A Contribution to the Empirics of Economic Growth. *Quarterly Journal of Economics*, 107 (May): 407–38.

♣ `Further Reading:` Acemoglu, Johnson and Robinson (2004). Institutions as the Fundamental Cause of Long-Run Growth. *Handbook of Economic Growth*.

CONVERGENCE

- Neo-classical Assumptions dropped in Endogenous growth model due to failure of cross-country convergence
  - Technological Change is exogenous
  - Similar technological opportunities are available everywhere
- Endogenous Growth emphasises that economic growth is an *endogenous* outcome of an economic system, not the result of forces that either drive the changes or impinge the economic system from outside
- External Aid: inconclusive literature on foreign aid (Easterly)
- FDI: Literature on FDI more positive

The Convergence Controversy

- Heston Summer dataset: Broad Sample of countries in the data set

  Future average growth of income per capita (1960-1985)

  versus

  Current income per capita (1960)

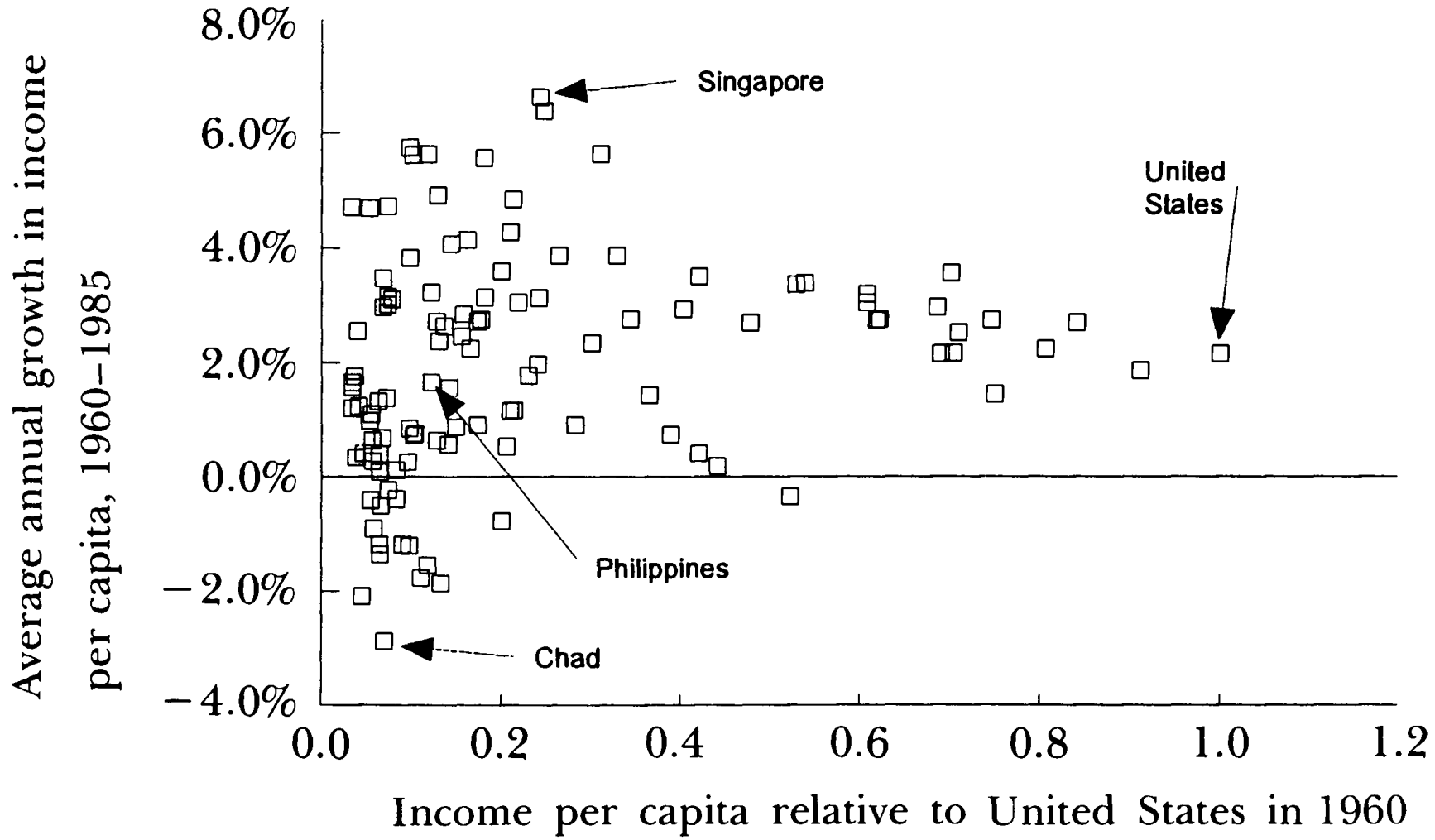
- Why aren't poor countries catching up like the low income US states catch (*converge*) with high income states?

Distance from US as a Predictor

Average Annual Income Growth versus Income per capita relative to US in 1960

- Does distance from US in 1960 predict annual growth since then
- No discernible trend

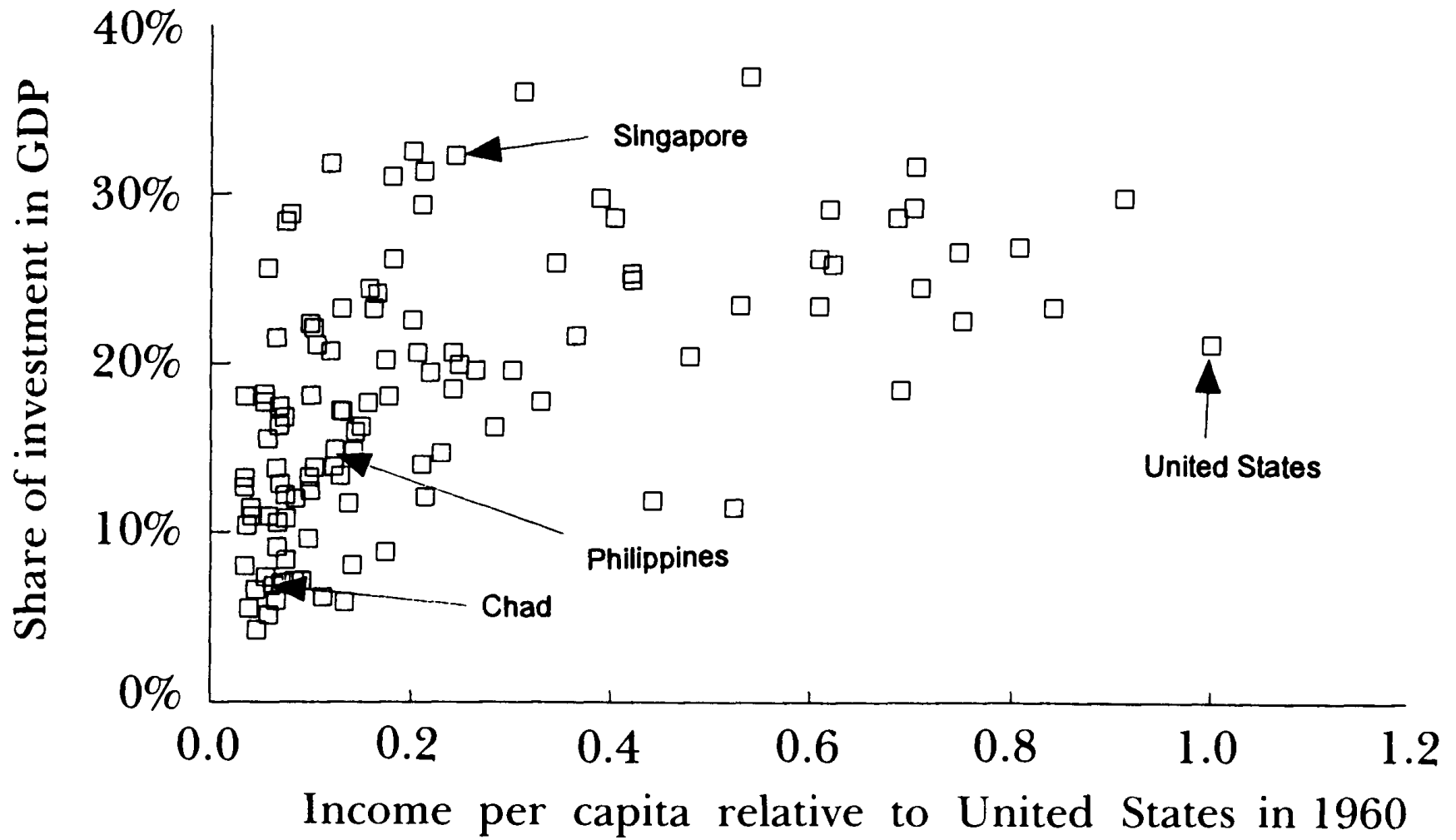
LOOKING FOR CONVERGENCE



Investment rate versus Level of per capita investment

- Higher income is associated with higher investment rate
- Magnitude of differences too small

Per Capita Income and Investment



Discarding the Neo-Classical Model

- Require a model where diminishing returns to capital accumulation set in more slowly
- Arrow (1962) knowledge spillover effects from capital investment
- Romer (1987) uses the spillover effects
  - A determined locally by knowledge spillovers
  - capital investment increase the level of technology for *all* firms in the economy

Public Goods

- Non-rivalrous and Excludability

	Rivalrous Goods	Non-rivalrous Goods
High	Lawyer Services	Encoded Satellite TV
↑	CD Player	
↑	Floppy Disks	Computer Code
↑		
Excludability		Tesco Operation Manuals
↓		
↓		National Defense
↓	Sterile insects	Basic R&D
Low		Calculus

Facts about Firms and Markets in Economy

Fact 1: There are many firms in the market economy

Fact 2: Discoveries differs from other inputs – many people can use them at the same time

- Ordinary goods are rival goods but information is a non-rival good

Facts about Firms and Markets in Economy

Fact 3: It is possible to replicate physical activities

- A is non-rival
- Double the physical inputs but there is no reason to double A
- Euler Theorem (CRS)[1] implies output divided up amongst the rival inputs
- nothing left to compensate non-rival input, e.g. researchers

Facts about Firms and Markets in Economy

Fact 4: Technological advances come from what people do

- Discoveries: Exogenous or random in nature
- Each discovery may be random but rate of discoveries is based on random chance and is not an exogenous.

  Research effort influences the randomness and makes discoveries it more likely.

Fact 5: Many individuals and firms have market power and earn monopoly rents on discoveries

- Information from discoveries maybe non-rival but they themselves are excludable
  - patents
  - The coke story
- Monopolistic Competition

Facts and Models

Neo-classical Growth Models

- Considered *Facts 1,2* & *3* ...
  treats technology as a public good
  - Non Rival
  - Excludable
- ... but postponned *Fact 4* & *5*
  - discoveries are excludable

Facts and Models

Endogenous Growth Models

- Shell (1966): In a competitive setup, no resource left over to pay for advances in A
  - A financed from tax revenue
- Arrow (1962): emphasize the role of private sector rather than public sector in the advance of technology
- Neo-Schumpeter models: incorporate Fact 4 (technological advances come from what people do) & Fact 5 (monopoly rents)
  - Schumpeter emphasised the importance of *temporary monopoly powers* as a motivating force in the innovative process
- Spillover models: (Romer, 1986) etc.

Early Endogenous Growth Models

- Both Romer (1986) & Lucas (1988) took *Fact 4* but not *Fact 5* into account
  - technology advances result of private investment
  - firms are price takers $\Rightarrow$ many firms could exist
- Lucas (1988): Investment in human capital has a spill-over effects that lead to increase in technology
- Romer (1986): Investment in physical capital has a spill-over effects that lead to increase in technology

Framework for Analysis

- Human capital: multidimensional, covering a broad range of investments – our focus on health and education broadly defined
  - Formal human capital accumulation: schooling, university
  - Informal human capital accumulation: learning by doing, on the job training
- Determinants of investments: parental characteristics hugely important

  Strauss and Thomas: clear effects of education investments on health outcomes and of health investments on education outcomes

Three Questions

We want to look at three critical issues in this literature

(i) Does increasing the supply of education improve education attainment - Duflo

(ii) Does increasing the supply of education lead to improvements in labour market outcomes – Duflo

(iii) Can investments in health affect education attainment – Kremer and Miguel

- Problems as regards (i) and (ii) – ability, liquidity constraints or parental characteristics may be driving the results
- Difficult to find exogenous sources of variation in education, i.e., standard problem in policy analysis
- Parental and community characteristics do not really work as instruments because they also typically enter into education or wage equation
- Difficult to isolate the impact of an expansion of education – ideally want randomised trial which are very difficult to carry out in the real world

Dreze and Sen: "Hunger and Public Action" – countries which put in *greater investments* in basic health and education see big *returns in terms of poverty reduction* and *growth*

We don't have to wait for growth – *investing early in human capital education/literacy* – foundations of public action

Investigating the Human Capital Effect

Experiments: treatment / control

- only way of getting truly exogenous policy variation
- Big area of work now, e.g., textbooks, devolution of school funding
- Typically there is a researcher-NGO partnerships, e.g., MIT Poverty Action Lab

Random Experiment

$$y + i = \alpha + \beta T_i + \gamma t_i + \delta (T_i \cdot t_i) + \varepsilon_t$$

- i $= 1, \ldots, N$ individuals
- T_i $T_i = 0, 1$ denotes control and treatment group respectively
- t_i $t_i = 0, 1$ denotes pre-treatment and post-treatment group respectively
- α is a constant term
- β is the treatment group specific effect (to account for average permanent differences between treatment and control)
- γ a time trend common to control and treatment groups
- δ the true effect of treatment

DUFLO (2001)

Schooling and Labour Market Consequences of School Construction in Indonesia

1973-78: Indonesian government constructed over 61000 primary schools

- Use the policy experiment to examine impact on *education* & *wages*
- Identification strategy:
  - (i) only some cohorts affected
  - (ii) intensity of program in inverse proportion to level of enrolment

– Education of men who were young enough when the program was launched should he higher *than* education of older men in all regions

– difference should be larger in the regions that received more schools

Difference in Difference Estimator

- Difference in difference estimator: Controls for systematic variation of education both across *regions* and across *cohorts* and allow the author to isolate the *programme effects*
- Only combination of the two variables is treated as exogenous (δ)
- Specifically: Exogenous variables (and the instruments in the wage equation) are the interactions between dummy variables indicating the *age of the individual in 1974* and the *intensity of the program between 1973 and 1978*

RESULTS

- Clear effect on education: Effect of one school built per 1000 children is to increase education for children aged 2–6 in 1974 by *0.12 years* in the whole sample and by *0.19 years* in the sample of wage earners.
- Clear effect on wages: increase in completed years of education has translated into an increase in wages of up to *3.8% for each additional school built*
- Estimates of exogenous returns to education using this exogenous variation in schooling (assuming that the program had no other effect than to increase the quantity of education) range from *6.4% to 9.1%*

Making a Miracle

Countries that transition from the being less developed to developed countries go through a takeoff phase

Growth rates during the take-off phase in excess of 10%

What account for this phenomenal growth: the candidates are

1. Capital accumulation: improbable
2. Technology advancement: improbable
3. Formal human capital accumulation: improbable
4. Informal human capital accumulation: most likely candidate
    - as countries change their export composition, the worker accumulate sector specific knowledge through *learning by doing*.

What role does formal education play in the facilitating informal human capital accumulation?

> increases cognitive abilities, thus lowering the *learning by doing* cost

Growth and Inequality

- Letting people have non-identical endowments allows us to explore effects of income and wealth inequality on growth
- *Conventional Wisdom:* Income inequality is good for *incentives* and thus should be good for growth – Rebelo (1991)
- Extracting the rents accumulated by the innovators should have a negative effect on growth

Inverted U Hypothesis

- Kuznets theory: transition from *traditional* or *rural* economy towards *industrial/urban* economy (with higher wages)
  1. The distribution of income *widens* in the early stages of development
     - Very few individuals have the required ability or human capital to move to the industrial sector
  2. The distribution of income should *narrow* in the latter stages of development
     - As more people are absorbed by the industrial sector
     - Wages in the rural sector catch up with the wages in the industrial sector due to the scarcity of of agricultural workers

Intergenerational Transfer of Wealth

Human Capital:

Individuals save in two distinct forms

- Save in physical capital
- Save by investing in education / human capital
  - increases the market value of labour supply in the future benefits the household directly or
  - altruistic parents invest into the education of their children

Growth and Income Distribution

- Galor and Zeria examine the linkages between *income distribution* and *growth* by exploring the *human capital investment* channel.
- 2 sectors: one that employs skilled labour and capital and the other that only employs unskilled labour.
  - Reminiscent of the Formal and Informal Sectors Besley Burgess (2004)

Skilled sector's CRS production function

$$Y^s = F(K_t, L_t^s)$$

The unskilled sector's production Function

$$Y^n = w_n L_t^n$$

Skilled & Unskilled Sector

	Skilled Sector	Unskilled Sector
Labour in sectors	L^s	L^n
Output	$Y^s = F(K, L^s)$	$Y^n = w_n L^n$
Return to labour	$w_s = F_L(K, L^s)$	w_n
Return to capital	$r = F_K(K, L^S)$	–

A worker needs to make an indivisible investment of h to acquire the *human capital* required to work in the *skilled sector*.

Complementarity between *skilled labour* and *capital* but no complementarity between *unskilled labour* and *capital*.

Consumption and Bequests

Individuals live for two periods where

- they can either work as *unskilled labour* in both periods or
- invest in human capital in the first period and work as *skilled labour* in the second period.

  - Unskilled: If they work as unskilled labour, they earn w_n in both periods.
  - Skilled: If they invest h into human capital in the first period, they can earn w_s in the second period.

The indivisibility of investment in human capital implies that there increasing returns to scale.

Consumption and Bequests

- Each individual has one parent and one child creating the connection between generations within dynasties and implying that there is no population growth.
- Individuals consume only in their second period of their life and derive pleasure out of leaving a bequest to their children.

  The individual utility from consumption c and bequest b to the next generation is given by:

$$u = \alpha \log(c) + (1 - \alpha) \log(b)$$

The amount a person inherits at the beginning of their life is x and the amount the person leaves as a bequest at the end of her life is b.

Consumption and Bequests

We find that their consumption and bequest are given by

$$c = \alpha m$$
$$b = (1 - \alpha)m$$

where m is the individual's lifetime income.

log utility functions are useful because they have the right shape and give us linear consumption functions when optimised.

- The individual consume α and bequest $(1 - \alpha)$ proportion of m, their lifetime income.

Consumption and Bequests

Langrangian that maximises the utility u subject to the inter-temporal budget constraint $c + b = m$.

$$\ell = \alpha \log(c) + (1-\alpha)\log(b) + \lambda[m - c - b]$$

First Order Conditions:

$$\frac{c}{\alpha} = \frac{b}{1-\alpha} = \frac{1}{\lambda} = m$$
$$\Rightarrow \quad u = \log(m) + [\alpha \log(\alpha) + (1-\alpha)\log(1-\alpha)]$$

Check that the Second Order Conditions are satisfied.

CREDIT MARKET IMPERFECTIONS

- Enforcement cost is the source of *friction* in credit markets: firms borrow at r and individuals borrow at i to invest in human capital.

$$i > r$$

It is risky to lend to individual borrowers for the purpose of investing in their human capital as they may run away without repaying the loan.

- *Potential borrowers* are individuals with insufficient inheritance x, who borrow $(h - x)$ to cover the shortfall.
- *Lenders* are individuals with generous inheritance x, who invest in their own human capital and then lend on the excess $(x - h)$ to the potential borrowers.

Lifetime Income & Bequests

Skilled Borrower: An individual who inherits x, which is insufficient for human capital investment h, *borrows* an amount $(h-x)$ at interest rate i to become a skilled worker. Her lifetime income is

$$m_s^{\text{borrower}} = w_s - (h-x)(1+i) < w_s$$

Skilled Lender: An individual who receives a sufficient inheritance x invests h in human capital and *lends* the rest on the capital markets at interest rate r. Her lifetime income is

$$m_s^{\text{lender}} = w_s + (x-h)(1+r) > w_s$$

Unskilled Worker: Lifetime income of an worker who remains unskilled and has a bequest of x, is

$$m_n = (x+w_n)(1+r) + w_n$$

- Becoming a skilled worker is only lucrative if an individual has the incentive to invest h of her own funds into her human capital and forgo
  - $h(1+r)$, the interest she could have earned by lending h on the capital markets and
  - the lifetime income she could have earned as an unskilled worker.

– **Assumption**: Ensures that the workers would always prefer to becomes skilled if they can garner the sufficient resources.

$$w_s \geq h(1+r) + w_n(1+r) + w_n \tag{1}$$

$$w_s - h(1+r) \geq w_n(2+r)$$

Bequest Amounts

- Using the fact that individuals bequest a $(1-\alpha)$ proportion of their lifetime income, we can find the amount each group would bequest.

$$
\begin{aligned}
b_s^{\text{borrower}} &= (1-\alpha)\left[w_s - (h-x)(1+i)\right] \\
b_s^{\text{lender}} &= (1-\alpha)\left[w_s + (x-h)(1+r)\right] \\
b_n &= (1-\alpha)\left[(x+w_n)(1+r) + w_n\right]
\end{aligned}
$$

Inter-generational bequests: Bequest amounts determine the distribution of wealth not only in in period t but also in period $t+1$ after the various groups have realised their inheritances.

Bequest Amounts

The bequest amounts can be rearranged as follows

$$
\begin{aligned}
b_s^{\text{borrower}} &= (1-\alpha)\left[w_s - (h-x)(1+i)\right] \\
&= (1-\alpha)\left[w_s - h(1+i) + (1+i)x\right] \\
b_s^{\text{lender}} &= (1-\alpha)\left[w_s + (x-h)(1+r)\right] \\
&= (1-\alpha)\left[w_s - h(1+r) + (1+r)x\right] \\
b_n &= (1-\alpha)\left[(x+w_n)(1+r) + w_n\right] \\
&= (1-\alpha)\left[w_n(2+r) + (1+r)x\right]
\end{aligned}
$$

- The above equations give us the slopes of the lines in the $x_{t+1} - x_t$ space.

  The non-skilled and the skilled lender have slopes $(1-\alpha)(1+r)x$.

  The skilled borrower has a steeper slope $(1-\alpha)(1+i)x$.

For a dynasty that inherits x_t in period t, the inheritance in period $t+1$ is given by

$$x_{t+1} = \begin{cases} b_n(x_t) & x_t < f \\ b_s^{\text{borrower}}(x_t) & f \leqslant x_t < h \\ b_s^{\text{lender}}(x_t) & h \leqslant x_t \end{cases}$$

- To summarise, dynasties that inherit less than g gravitate towards $\bar{x}_n$ and the ones that inherit more than g gravitate towards $\bar{x}_s$.

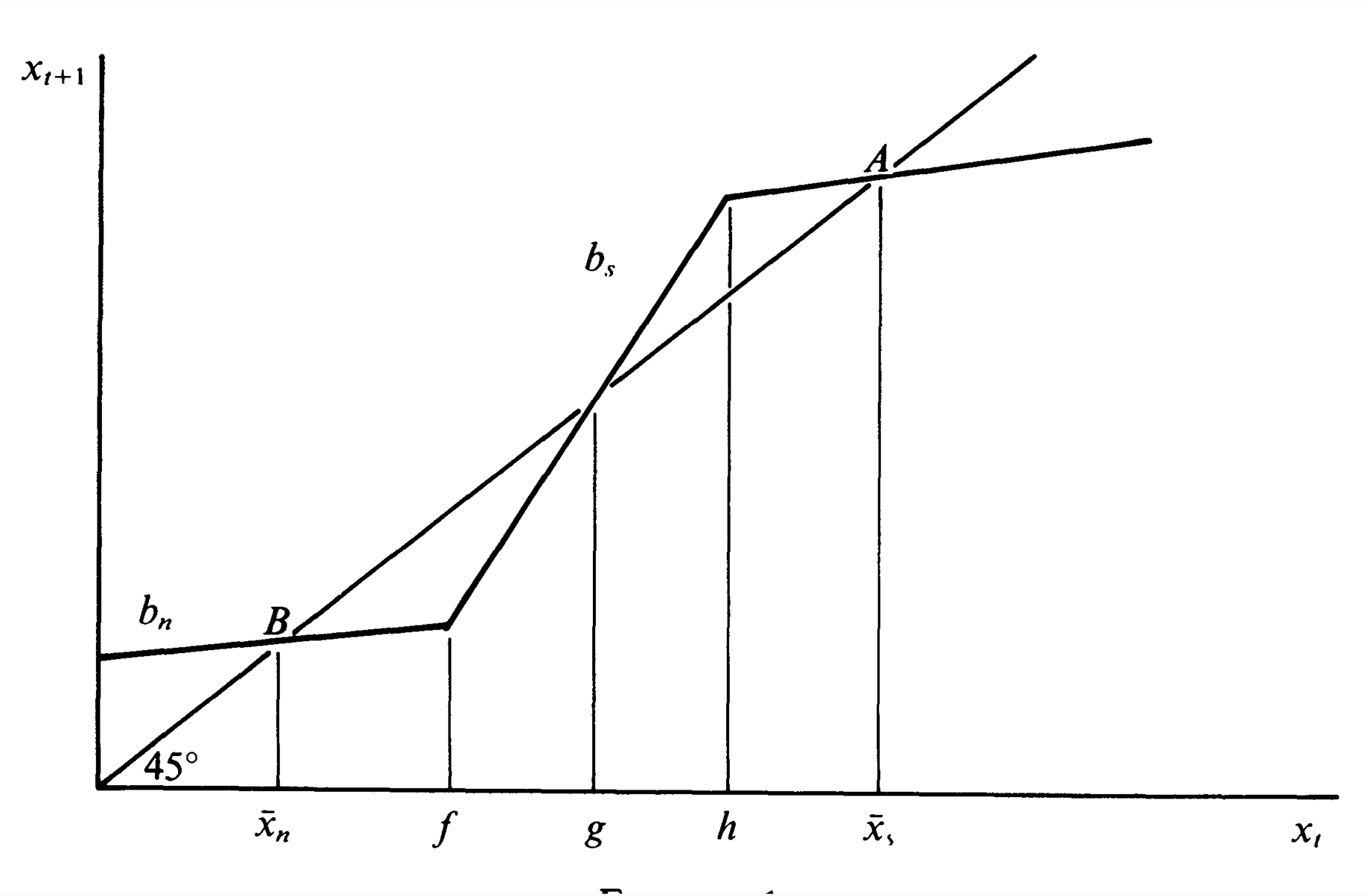


Figure: Inter-generational Wealth Dynamics

LONG-RUN

- Off a total labour force of L, let L^g be the number of individuals who initially inherit less than g and thus $\frac{L^g}{L}$ gives us the proportion of workers that would gravitate towards $\bar{x}_n$.
  The long run average wealth of the economy is given by

$$\left(1 - \frac{L^g}{L}\right)\bar{x}_s + \left(\frac{L^g}{L}\right)\bar{x}_n$$

  which is decreasing in $\frac{L^g}{L}$ (proportion of poor)

Importance of Middle-Class

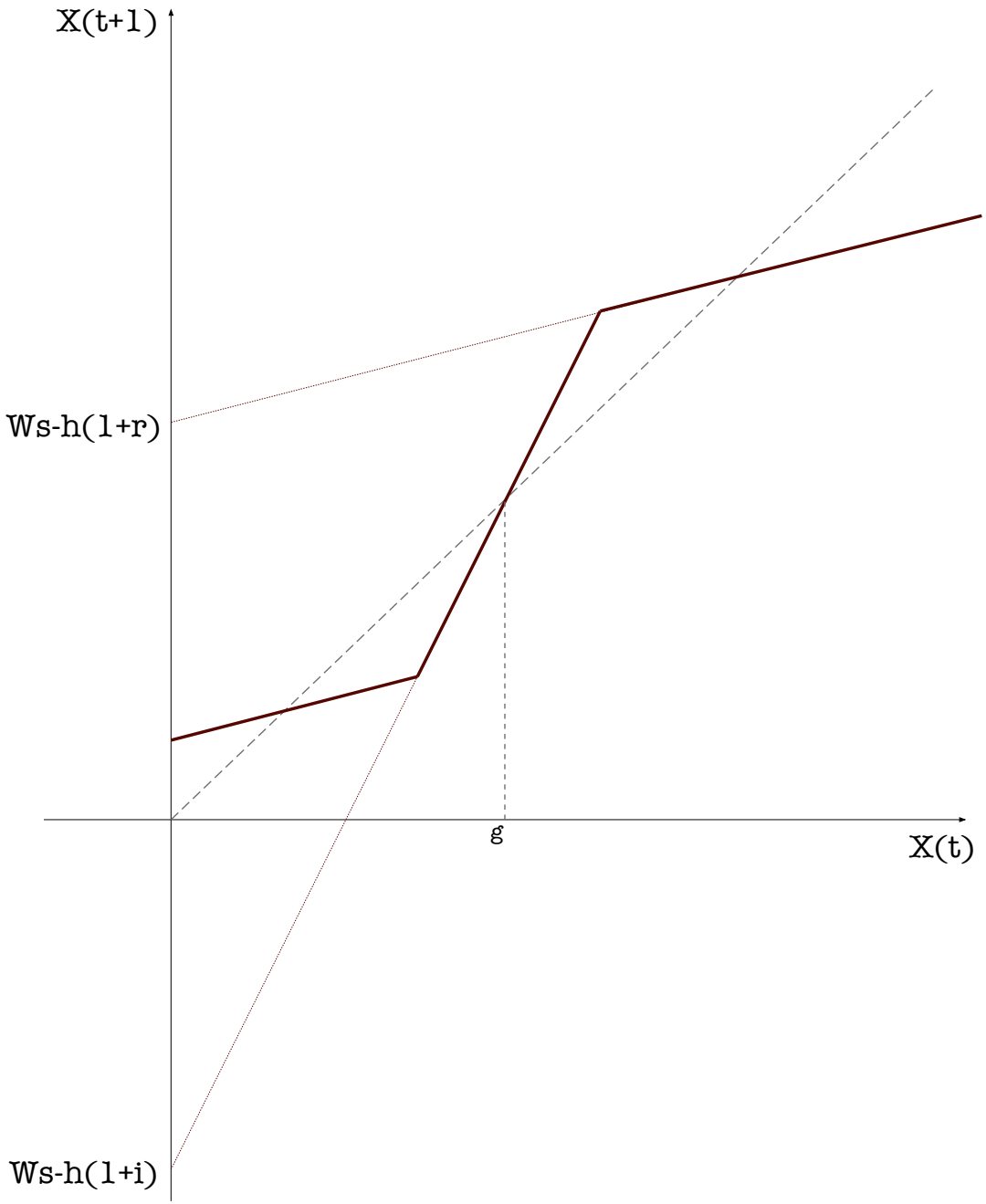
- A poor economy with most of the individuals with wealth below g ends up poor in the long run.
- An economy with where all wealth is concentrated in very few hands also ends up poor in the long run.
- The economy with best growth prospect is the one with a large middle-class. The long run equilibrium of the model depends on the initial distribution of wealth in the economy.

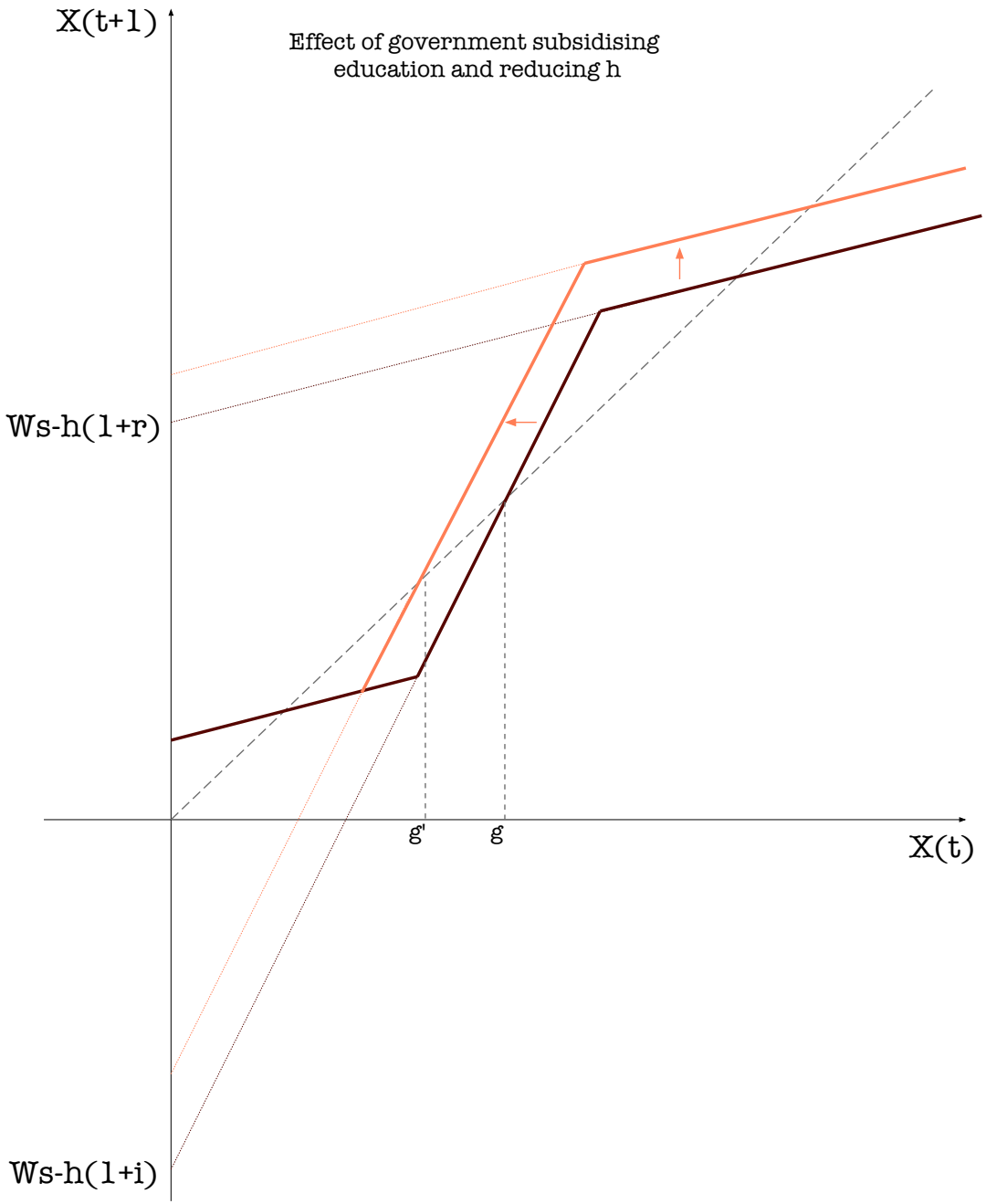
Growth

- Assume that w_n, productivity in the non-skilled sector grows that at rate α_n and w_s and h, productivity in skilled sector grows at α_s.
- The rate of growth of output per capita is a weighted average of α_n and α_s, where the weights depend on initial distribution of wealth.
  - Wealth distribution can affect non only the long run level of output but also the rate of growth

POLICY

1. Lowering the cost of monitoring the borrowers
2. Subsidising education
   - shifts the b_s^{borrower} curve to the left lowering both the values of f and g and increasing the invest and output in short and long run
   - Pareto improvement if the debt collection costs are higher than cost of tax collections
     - government avoids the need to keep track of each individual borrower by giving subsidy to all students and taxing everyone with high income with no need to know how much each individual borrows
     - Tax system already exists and so no fixed cost associated with starting a new tax collection system





SUMMARY

- Analyses the role of income distribution on growth through the human capital channel
- With capital market imperfections, distribution of wealth significantly affects the aggregate economic activity
- Indivisibility of investment in human capital ensures that this affects long run as well

Positive External Economies

Increasing interest in economic models with positive external economies

- Romer (1986a, 1986b) has shown that external economies may remove the traditional distinction between *factor accumulation* and *technical change* as a source of growth
- Murphy, Shleifer & Vishny (1989) – *market size effects* create external economies among firms investing in industrialisation and thus offer a rigorous formulation of Rosenstein-Rodan's (1943) "*big push*" theory of economic development
- Krugman (1981,1987) – use external economies to formulate the "*uneven development*" model in which division of the world into rich and poor takes place endogenously and historical accidents get locked in through learning effects

External Economies

External Economies → multiple equilibria

with external economies, the return from committing resources to some activity is higher, the greater the resources committed.

- Krugman (1987) – the rate of learning in a sector is larger the larger the sector is
- Adserà & Ray (1998) – returns of capital in the modern sector is higher, the more capital is invested in modern sector

  The reason why capital may move to a currently unfavoured sector, despite the lag in realisation of externalises, is because a latter move will involve a higher cost.

External Economies

In the increasing returns and externality literature, mulitiple equilibria is central part of the story

Once the multiple equilibria has been established, the question is which equilibrium would actually be reached?

One View: Choice amongst the multiple equilibria is resolved by *history*

- Backward looking dynamics

Contrary View: Equilibria is resolved by *expectations*

- Forward looking dynamics
- Self-fulfilling prophecy

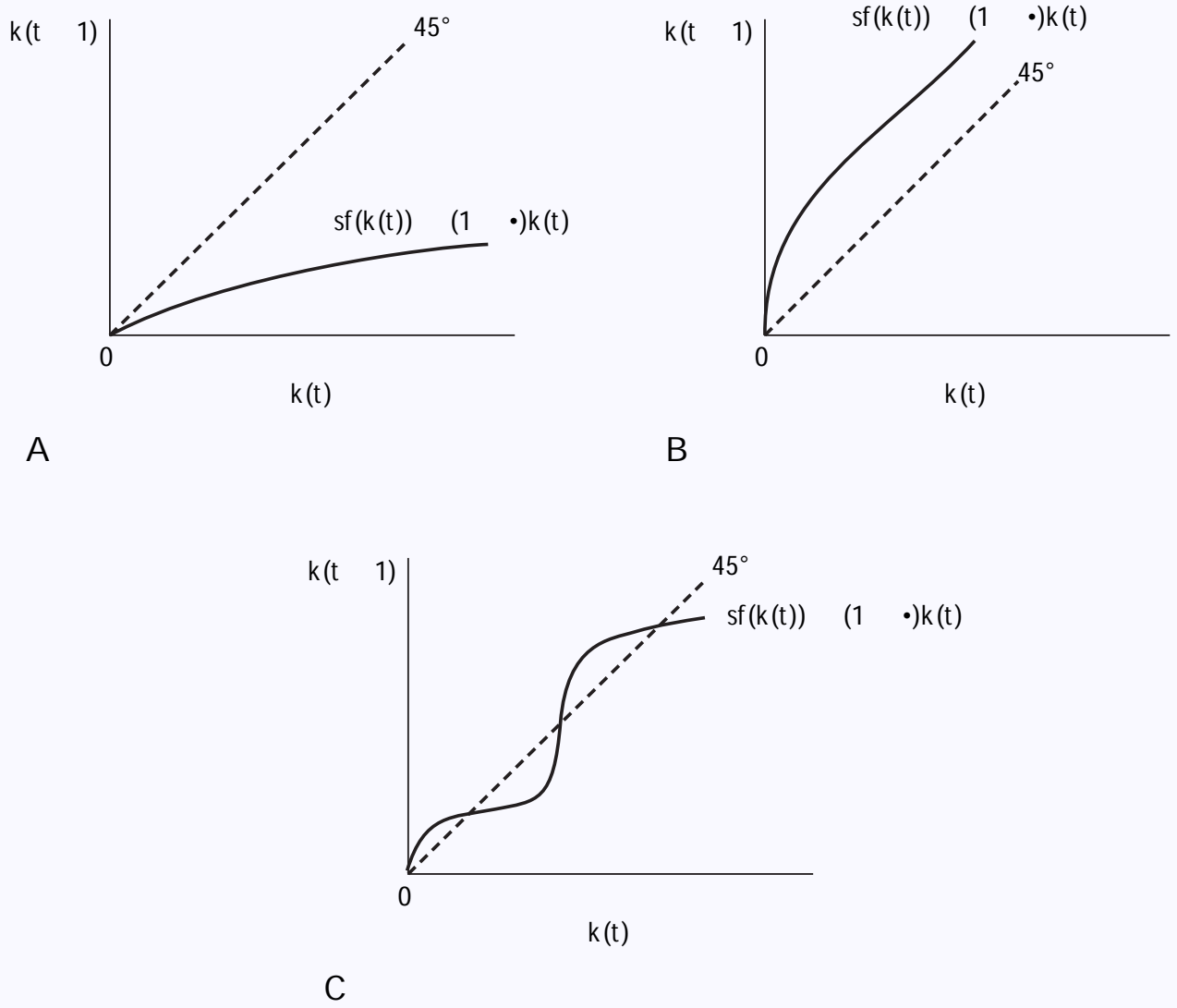


FIGURE 2.5 Examples of nonexistence and nonuniqueness of interior steady states when Assumptions 1 and 2 are not satisfied.