Taxation and Long-Run Growth

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Lecture 3
Redistribution and growth

This lecture examines a number of mechanisms through which income redistribution can increase growth. First, we consider a framework with imperfect capital markets. In this setup, redistribution may have both an *opportunity creation* effect and an *incentive* effect that increase investment and foster growth. Second, we exploit the fact that, when incomes are uncertainty, redistribution creates insurance, and show that in an R&D-driven growth model (with perfect capital markets) redistribution can accelerate the pace of innovation.

References

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Aghion, P. and P. Howitt. 1998. *Endogenous Growth Theory*, MIT press. Chapter 2.
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The Effects of Inequality on Growth: An $A - K$ Formulation

Traditional view –> *trade-off* between productive efficiency/growth and redistribution

Two main considerations

1. *investment indivisibilities*
2. *incentive* considerations

New approach based on credit market imperfections

The opportunity-enhancing effect of redistribution

Discrete-time version of the $A - K$ model
One good
Continuum of OLG families, $i \in [0, 1]$
Intertemporal utility of individual i born at t

$$U_t^i = \ln c_t^i + \rho \cdot \ln d_t^i$$

Production

$$y_t^i = (k_t^i)^\alpha (A_t)^{1-\alpha}$$

where

$$A_t = \int_0^1 y_{t-1}^i di = y_{t-1}$$

Inequality: Individuals differ in their initial endowments of capital

$$w_t^i = \varepsilon_t^i \cdot A_t$$

ε_t^i is an i.i.d shock with mean one, so that $\int_0^1 w_t^i di = A_t$

Individual i can either "consume" her endowment or invest it

Capital market imperfections: Credit simply is unavailable

Redistribution: ex ante redistribution of endowments

$$\hat{w}^i = w^i + \beta(A - w^i), \quad 0 < \beta < 1$$

No credit restrictions

Individuals solve

$$\max_{b^i,k^i} \ln(w^i + \beta(A - w^i) + b^i - k^i) + \rho \ln(y^i - rb^i)$$

The first-order conditions are

$$A^{1-\alpha}(k^i)^\alpha - rb^i = \rho r(w^i + \beta(A - w^i) + b^i - k^i)$$

and

$$r = \alpha \left(\frac{A}{k^i}\right)^{1-\alpha}$$

Which yield

$$k = \frac{\rho\alpha}{1+\rho\alpha} A = s \cdot A$$

The steady-state growth rate is

$$g = \ln\left(\frac{y_t}{y_{t-1}}\right) = \ln\left(\frac{k^\alpha A^{1-\alpha}}{A}\right) = \alpha \ln s$$

Distribution and redistribution have no impact on growth

No borrowing

Individual i choose k^i so as to:

$$\max_{k^i} \left\{ \ln(w^i - k^i) + \rho \cdot \ln y^i \right\}$$

which yields

$$k^i = \frac{\rho\alpha}{1+\rho\alpha} w^i = s \cdot w^i$$

Then,

$$y = \int_0^1 y^i di = \int_0^1 A^{1-\alpha} s^\alpha (w^i)^\alpha di$$

Hence:

$$g = \alpha[\ln s - \ln A] + \ln \int_0^1 (w^i)^\alpha di$$

Theorem: Let u be a concave function. Let X and Y be two random variables, such that the expectations $Eu(X)$ and $Eu(Y)$ exist and are finite, and such that Y is obtained from X through a mean-preserving spread. Then $Eu(X) \geq Eu(Y)$.

More inequality is bad for growth when capital markets are highly imperfect

No borrowing and redistribution

Individual i's problem is

$$\max_{k^i} \left\{ \ln(w^i + \beta(A - w^i) - k^i) + \rho \cdot \ln y^i \right\}$$

which yields

$$k^i = s \cdot ((1-\beta)w^i + \beta A).$$

As β increases, investments by the poorly endowed will increase whilst investments by the rich will decrease

The "*opportunity creation*" effect dominates

$$y = \int_0^1 y^i di = \int_0^1 A^{1-\alpha} s^\alpha ((1-\beta)w^i + \beta A)^\alpha di$$

and

$$g = \alpha[\ln s - \ln A] + \ln \int_0^1 ((1-\beta)w^i + \beta A)^\alpha di$$

Using the concavity of the $z \mapsto z^\alpha$ function

$$\frac{dg}{d\beta} > 0$$

More redistribution is good for growth when capital markets are highly imperfect

The incentive effects of redistribution

Aghion-Bolton (1997)

Challenge the view that the incentive effect of redistribution is always negative

OLG families, indexed by $i \in [0, 1]$

Utility of individual i

$$U_t^i = d_t^i - c(e_t^i)$$

where the effort cost is $c(e^i) = A_t \frac{(e^i)^2}{2}$

As before

$$w_t^i = \varepsilon_t^i \cdot A_t$$

The production technology

1. *fixed* and indivisible capital outlay equal to $k_t^i = \varphi \cdot A_t$
2. the (conditional) output from investment is

$$y_t^i = \begin{cases} \sigma \cdot A_t \text{ with probability } e_t^i \\ 0 \text{ with probability } 1 - e_t^i, \end{cases}$$

Outcomes y_t^i are i.i.d. across individuals

Individuals with initial endowments $w_t^i < \varphi A_t$ will borrow $b_t^i = \varphi A_t - w_t^i$ from wealthy individuals

The source of capital market imperfection will be moral hazard with limited liability

Assumptions

1. efforts e^i are not observable
2. a borrower's repayment to his/her lenders cannot exceed his/her second period output y_t^i

First-Best

If either (a) or (b) were violated $\rightarrow$ all agents exert first-best effort

$$e^* = \arg\max_e \{e(\sigma A) - c(e)\} = \sigma$$

Growth rate is unaffected by distribution

$$g = \ln \frac{\int_0^1 y_t^i \cdot e^i di}{y_{t-1}} = \ln \frac{\sigma A_t \cdot \int_0^1 \sigma di}{A_t} = \ln \sigma^2$$

Imperfect capital markets

Optimal repayment schedule $R(w^i)$ is such that

$$
\begin{aligned}
R(w^i) &= (\varphi A - w^i)\rho && \text{if project succeeds,}\\
&= 0 && \text{if project fails,}
\end{aligned}
$$

A borrower will choose her effort e^i to maximize

$$\max_e \quad e(\sigma A - \rho(\varphi \cdot A - w^i)) - A\frac{e^2}{2}$$

$$e^i = \sigma - \rho\varphi + \rho \cdot \frac{w^i}{A} = e(\rho, w^i)$$

The lower a borrower's initial wealth, the *less* effort she will exert

Redistributing wealth towards borrowers will have a *positive* effect on their effort *incentives*

Lump-sum tax $t^i < w^i - \varphi A$ on the endowment of individuals with $w^i > \varphi A$, and redistribute the revenue amongst borrowers

This, will

1. not affect the effort e^* supplied by the wealthy, as $w^i - t^i > \varphi A$
2. increase the effort supplied by any subsidized borrower

Unambiguously positive *incentive* effect on growth,

$$g = \ln \frac{\int e^i \cdot \sigma A}{A} = \ln \sigma + \ln \int_0^1 e^i di$$

with efforts e^i either increasing or remaining constant as a result of redistribution.

Income Redistribution in a Schumpeterian Growth Model
C. García Peñalosa and J-F. Wen

Population
OLG - two period lifes
N individuals in each generation

L unskilled	manufacturing	
H skilled	entrepreneurs	R_t
	producers	$M_t = H - R_t$

Production Technologies
Final good

$$Y_t = A_t x_t^{\theta} L^{1-\theta}$$

competitive sector

Intermediate good

$$x_t = M_t$$

may be monopolistic or competitive

Quality ladder

$$
\begin{aligned}
A_{t+1} &= \gamma A_t \text{ if an innovation occurs in } t-1 \\
&= A_t \quad \text{if no innovation occurs in } t-1 \\
& \quad A_0 \text{ is given, } \gamma > 1
\end{aligned}
$$

Probabilities

$$
\begin{aligned}
\Pr(\text{at least one innovator}) &= \lambda R_t^{\eta} \\
\Pr(\text{no innovator}) &= 1 - \lambda R_t^{\eta}
\end{aligned}
$$

where $0 \leq \eta \leq 1$

$$
\begin{aligned}
\Pr(\text{patent to } i | \text{ innovation}) &= 1/R_t \\
\Pr(\text{no patent to } i | \text{innovation}) &= (R_t - 1)/R_t
\end{aligned}
$$

Patent: lasts for a *single* period
then technology is freely available

No storage

Market Structure, Profits and Wages

Monopoly $\phi_t = 1$

$$\max_{x_t} \Pi = p(x_t)x_t - w_t^1 x_t$$

Then

$$\begin{aligned} p_t^1 &= \frac{w_t^1}{\theta} > w_t^1 \\ v_t^1 &= (1-\theta)\frac{Y_t^1}{L} \\ w_t^1 &= \theta^2 \frac{Y_t^1}{M_t^1} \\ \Pi_t &= (1-\theta)\theta Y_t^1 \end{aligned}$$

Competition $\phi_t = 0$

$$\begin{aligned} p_t^0 &= w_t^0 \\ v_t^0 &= (1-\theta)\frac{Y_t^0}{L} \\ w_t^0 &= \theta \frac{Y_t^0}{M_t^0} \end{aligned}$$

Equilibrium with Risk Neutrality

Utility

$$U(C^j) = C^j_j + C^j_{j+1}$$

Arbitrage

$$U^\phi_{mt} = U^\phi_{et}, \quad \phi = 0, 1$$

that is

$$\frac{\theta^{1+\phi} Y^\phi_t}{M^\phi_t} = \lambda \left(R^\phi_t \right)^{\eta - 1} (1-\theta)\theta Y^1_{t+1}$$

Steady state

$$\begin{aligned} y^\phi &= \frac{Y^\phi_t}{A_t} = L^{1-\theta} \left(M^\phi \right)^\theta \\ U^\phi_{et} &= A_t u^\phi_e \end{aligned}$$

and

$$\begin{aligned} R^\phi_t &= R^\phi_{t+1} = R^\phi \\ M^\phi_t &= M^\phi_{t+1} = M^\phi \end{aligned}$$

$$
\begin{aligned}
\frac{\theta^2}{H - R^1} &= \lambda \left(R^1\right)_{\eta-1} (1-\theta)\theta \\
\frac{\theta}{H - R^0} &= \lambda \left(R_t^0\right)_{\eta-1} (1-\theta)\theta \left(\frac{H - R^1}{H - R^0}\right)_{\theta}
\end{aligned}
$$

The Probability of Innovation

Probabilities of innovation in each period

$$Q = \begin{pmatrix} q^1 & 1 - q^1 \\ q^0 & 1 - q^0 \end{pmatrix}$$

where

$$q^1 \equiv \lambda \left(R^1\right)^\eta \quad \text{and} \quad q^0 \equiv \lambda \left(R^0\right)^\eta$$

The steady state probability of innovation q

$$\begin{aligned} q &= \frac{q^0}{1 - q^1 + q^0} \\ &= \frac{\lambda \left(R^0\right)^\eta}{1 - \lambda (R^1)^\eta + \lambda (R^0)^\eta} \end{aligned}$$

Economic Growth

$$g_t = \ln \left(\frac{A_{t+1}}{A_t}\right) + \ln \left(\frac{M_{t+1}}{M_t}\right)$$

The average growth rate in the long-run

$$\begin{aligned} g &= E(\ln A_{t+1} - \ln A_t) \\ &= q\left(R^0, R^1\right) \ln \gamma \end{aligned}$$

Taxation

Optimal linear tax system

$$T(I) = -B + \tau I$$

Balanced budget in each period

$$\begin{aligned} N \cdot B_t^1 &= \tau^1 \left(\Pi_t + w_t^1 M_t^1 + v_t^1 L \right) \\ &= \tau^1 Y_t^1 \end{aligned}$$

and

$$\begin{aligned} N \cdot B_t^0 &= \tau^0 \left(w_t^0 M_t^0 + v_t^0 L \right) \\ &= \tau^0 Y_t^0 \end{aligned}$$

Three features

1. individuals born at t receive transfer at end of t
2. different taxes in the two states of the world
3. considers individual uncertainty but ignores aggregate uncertainty

Risk-Aversion

Utility

$$U(C^j) = \left(C^j_j + C^j_{j+1}\right)^{\alpha}, \quad 0 < \alpha < 1$$

Manufacturing workers

$$\begin{aligned} U^{\phi}_{mt} &= \left((1-\tau^{\phi})w^{\phi}_{mt} + B^{\phi}_t\right)^{\alpha} \\ &= \left(\frac{Y^{\phi}_t}{N}\right)^{\alpha} \left((1-\tau^{\phi})\frac{\theta^{1+\phi}N}{M^{\phi}_t} + \tau^{\phi}\right)^{\alpha} \end{aligned}$$

Entrepreneurs

$$\begin{aligned} U^{\phi}_{et} &= \lambda \left(R^{\phi}_t\right)^{\eta-1} \left(C^{\phi}_{\pi t}\right)^{\alpha} \\ &\quad + \left(1-\lambda \left(R^{\phi}_t\right)^{\eta-1}\right) (B^{\phi}_t)^{\alpha} \end{aligned}$$

with

$$C^{\phi}_{\pi t} \equiv \left((1-\tau^{1})(1-\theta)\theta Y^{1}_{t+1} + \frac{\tau^{\phi}Y^{\phi}_t}{N}\right)$$

Steady state

Equilibrium

$$U_{et}^{\phi} = U_{mt}^{\phi}$$

Monopoly

$$\left(\frac{(1-\tau^1)\theta^2}{H-R^1}+\frac{\tau^1}{N}\right)^{\alpha} = \left(1-\lambda\left(R^1\right)^{\eta-1}\right)\left(\frac{\tau^1}{N}\right)^{\alpha} + \lambda\left(R^1\right)^{\eta-1}\left((1-\tau^1)(1-\theta)\theta\gamma+\frac{\tau^1}{N}\right)^{\alpha}$$

Competition

$$\left(\frac{(1-\tau^0)\theta}{H-R^1}+\frac{\tau^0}{N}\right)^{\alpha} = \left(1-\lambda\left(R^0\right)^{\eta-1}\right)\left(\frac{\tau^0}{N}\right)^{\alpha} + \lambda\left(R^0\right)^{\eta-1}\left((1-\tau^1)(1-\theta)\theta\gamma\left(\frac{H-R^1}{H-R^0}\right)^{\theta}+\frac{\tau^0}{N}\right)^{\alpha}$$

Taxation with Risk Neutrality

With $\alpha = 1$

$$
\begin{aligned}
\frac{(1-\tau^1)\theta^2}{H-R^1} + \frac{\tau^1}{N} = {} & \left(1 - \lambda \left[R^1\right]^{\eta-1}\right)\frac{\tau^1}{N} \\
& + \lambda \left[R^1\right]^{\eta-1} \left((1-\tau^1)(1-\theta)\theta\gamma + \frac{\tau^1}{N}\right)
\end{aligned}
$$

then

$$
\frac{\theta^2}{H-R^1} = \lambda \left[R^1\right]^{\eta-1}(1-\theta)\theta\gamma
$$

and the tax has no effect

Also

$$
\begin{aligned}
\frac{(1-\tau^0)\theta}{H-R^1} = {} & (1-\tau^1)\lambda \left[R^0\right]^{\eta-1} \\
& (1-\theta)\theta\gamma \left(\frac{H-R^1}{H-R^0}\right)^{\theta}
\end{aligned}
$$

and taxes have no effect as long as $\tau^0 = \tau^1$

The Effect of Taxes

$$\left(\frac{(1-\tau^1)\theta^2}{H-R^1}+\frac{\tau^1}{N}\right)^\alpha = \left(1-\lambda\left[R^1\right]^{\eta-1}\right)\left(\frac{\tau^1}{N}\right)^\alpha + \lambda\left[R^1\right]^{\eta-1}\left((1-\tau^1)(1-\theta)\theta\gamma+\frac{\tau^1}{N}\right)^\alpha$$

Three effects

- ‘insurance premium’ –> discourages entrepreneurship
- ‘insurance effect’ –> encourages entrepreneurship
- ‘redistribution effect’ –> discourages production

The role of social insurance is crucial: at $\tau^1 = 0$, the effect of τ^1 on the r.h.s. is *infinite*

Proposition 1: *The introduction of a small amount of redistribution increases research and hence the long-run probability of innovation.*

Proposition 2: *The introduction of a small amount of redistribution can be Pareto efficient.*