

# **A Simple Model of Wealth Inequality and the Role of Capital Taxation in Overcoming It**

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Based on joint work with

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# Some recent theoretical results on inequality

- Using diffusion model, analyzing long term wealth inequality as a balancing of centrifugal and centripetal forces, and changes in wealth inequality as changes in those forces
  - Simple formula for tail inequality in terms of growth rate,  $n$ , variance of returns, and share of capital

$$D^* = 2 \frac{1-s_k}{s_k^2 n \bar{\sigma}^2}$$

More tail inequality if

- (a) Variance of returns is higher
- (b) Share of capital is higher
- (c) If the elasticity of substitution is less than or equal to unity, a lower savings rate or high  $n$  leads to more inequality

# What we are seeing is a movement from one equilibrium to another

- Need to identify factors contributing to movement
  - Among these are growing rents
    - Including monopoly rents
  - Public policies
    - *Rewriting the rules of the market economy*
    - Markets don't exist in a vacuum; they have to be structured
    - New rules, interpretations and enforcement of existing rules
    - Favored market power, weakened labor power
  - Changes in the structure of the economy

# Theory can explain macro- and micro- changes

- Growth in wealth/income ratio even as capital-output ratio declines
  - Wealth includes capitalized value of rents
- Is consistent with growth of both interfirm inequalities and intra-firm inequalities (Furman-Orszag)
  - Persistence of large returns differences
    - Puzzle of why workers (of a given ability) in high profitability firms get paid more
    - Inconsistent with standard competitive theories
  - Drawing upon efficiency wage theory
  - Overall inequality affected by endogenously determined vertical (dis-)integration

# *Increased rents as explaining the paradoxes of modern growth*

- *If* capital and wealth were the same, then the observed increase in the wealth income ratio should have led to a decreased share of capital, given the wealth of studies suggesting an aggregate elasticity of substitution less than unity
- Should also have also led to an increase in wages
  - Skilled biased technological change only affects *relative* wages, not appropriate weighted average wage
  - How can wages and interest rates *both* decline?
- Disconnect between productivity and compensation
  - No sudden change in technology that can explain sudden change
  - Can be explained by changes in rules, norms, including globalization
- But paradoxes are resolved if we recognize distinction between *wealth* and *capital*.
  - While wealth/income or wealth/per capita has increase, capital/income and capital/per capita has decreased, at least for many advanced countries

# *Increased rents explain other paradoxes*

- Decreasing investment in spite of seemingly high *average* returns
- Finance not constraint
  - Large firms sitting on trillions in cash
  - Real interest rates negative
- Increase in market power
  - Marginal return lower relative to average return
- Corporate governance:
  - Short termism
    - Explained by variety of changes in “rules” (tax, accounting) and practices
  - Increase in executive compensation
    - Again explained by variety of changes in “rules” (tax, accounting) and practices
    - Decrease both investment in the future of the company and workers’ compensation

# There may be multiple political-economic equilibria

- High levels of economic inequality result in high levels of political inequality
  - Which result in pro-inequality economic and political systems,
  - And pro-inequality economic and political systems result in higher levels of inequality.
- A country like the US can be trapped in the bad equilibrium.
  - Others have been fortunate to be in a good equilibrium
- There may be multiple equilibria: high levels of economic inequality result in high levels of political inequality,
  - Which result in pro-inequality economic and political systems, and pro-inequality economic and political systems
  - Result in higher levels of inequality.
- A country like the US can be trapped in the bad equilibrium. Others have been fortunate to be in a good equilibrium

# Simple model

## Rent seeking increases as the tax rate decreases

Assumptions:

- Tax benefit  $b$  for an industry could be achieved through the expenditure of  $e$
- Industry acts cooperatively in setting  $e$  to maximize industry after tax profits (where  $\pi$  gives the maximized value of profits at any level of benefits  $b$ )

$$\Pi = (1-\tau)\pi(b(e)) - e,$$

yielding

- $(1-\tau)\pi'(b^*) = 1.$

Sector takes tax rates as given. The solution  $\{b^*, e^*\}$  a function of  $\tau$

$$b^* = b^*(\tau), \text{ with } b^{*'} < 0$$

It pays to put less effort into getting benefits when tax rate is higher.

# Rent seeking decreases as tax rate increases

Rents defined as the difference between what profits would have been at  $b=0$  and at  $b^*$

$$(1) \quad R = \Pi(b^*) - \Pi(0) = R(\tau)$$

Hence Rents increase as the tax rate decreases

$$(2) \quad dR/d\tau < 0$$

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Hence **Rents increase as the tax rate decreases**

$$(2) \quad dR/d\tau < 0$$

# Lobbying for a low tax rates

## With high rents corporations strive for lower tax rates

- Corporate lobbying E. Tax rate depends on lobbying effort:  $\tau(E)$ ,  $\tau' < 0$ ,  $\tau'' > 0$
- $\text{Max } (1 - \tau) \Pi(b^*) - E$

Taking  $b^*$  as given yields  $E^*$  is solution to

$$(3) \quad -\tau' \Pi^* = -\tau' \{R + \Pi(0)\} = 1.$$

yielding

$$d \ln E / d \ln R = R / \xi (R + \Pi(0)) > 0$$

where  $\xi = -d \ln \tau' / d \ln E > 0$ . Thus,

$$(4) \quad d \ln \tau / d \ln R = -\eta d \ln E / d \ln R = -\eta R / \xi (R + \Pi(0))$$

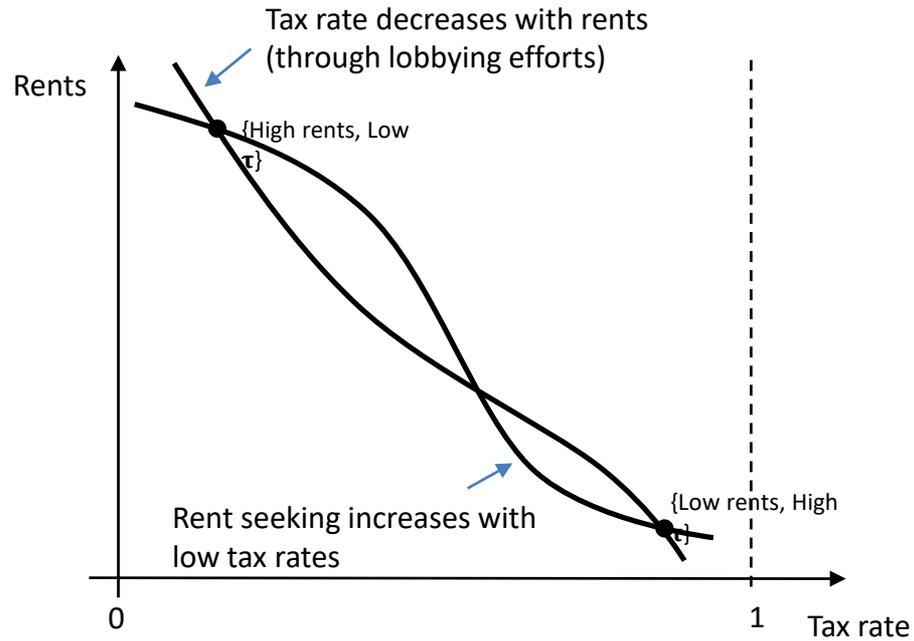
where  $-\eta = d \ln \tau / d \ln E$ .

***The lower the rents, the higher the equilibrium corporate income tax rate.***

# Full market equilibrium

- Equilibrium simultaneous solution to (1) and (3)
- Using (2) and (4) there can be multiple equilibria
- The economy can be trapped in a bad equilibrium, with (corporate) tax rates inducing high levels of rent seeking (equation 1); and high levels of rents inducing high levels of effort at lowering the corporate income tax—and achieving that (equation 3).

# Multiple equilibria



# Alternative perspective

- Capitalism is associated with ever-growing inequality
  - There was a short period, after World War II, when this was not true
  - We are now returning to “norm”
- Piketty’s model assumed  $r > g$ 
  - May be true historically
  - But  $r$  is overall return to capital, *including rents*
  - *Without rents, eventually  $r < g$* 
    - Failure of observed  $r$  to decrease a result of diminishing marginal returns to capital combined with increasing market power
  - What matters is magnitude of  $sr(1-t)$  relative to  $g$ 
    - Evidence is that  $sr(1-t) < g$
    - True eventually in standard (Solow) growth models
  - Borderline case  $sr(1-t) = g$ 
    - In that case, amongst capitalists, there is ever growing wealth inequality

## The new challenge of automation and what to do about it

- Machines are becoming increasingly better at complex tasks such as driving cars, conversing, etc. (Brynjolfsson and McAfee, 2011, 2014)
- Frey and Osborne (2013): 47% of US jobs are at risk of being replaced by machines, hence: concerns about increased wealth concentration and human obsolescence
- Autor (2015): Evidence for both substitution and complementarity of labor and machines. Substitution might dominate in the short run (Acemoglu and Restrepo, 2017).

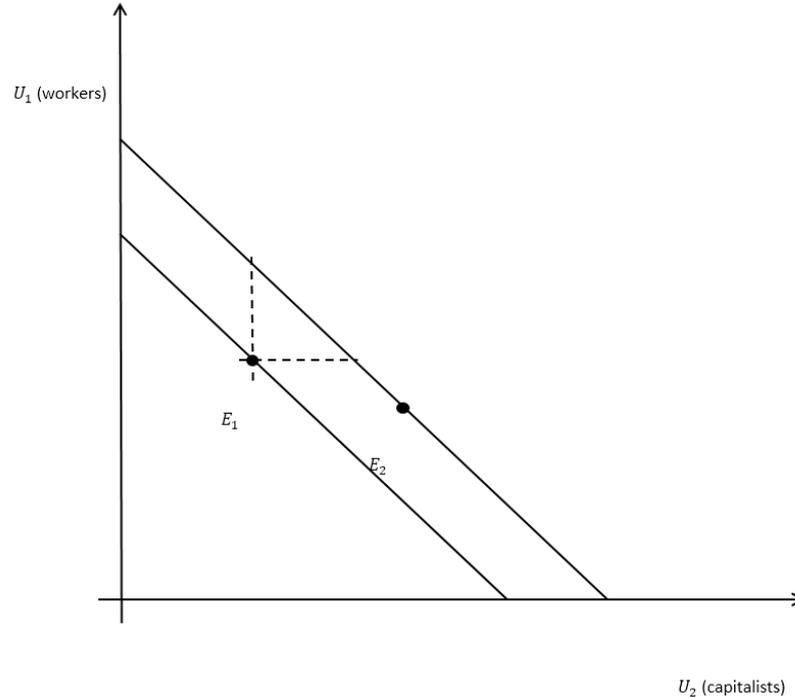
### Preventing a low-employment, high-inequality future

- Bill Gates (Feb, 17, 2017): Tax the robots!
- “ ... the best way to reduce inequalities with respect to labor ... is to invest in education” (Piketty 2014: 306-7)

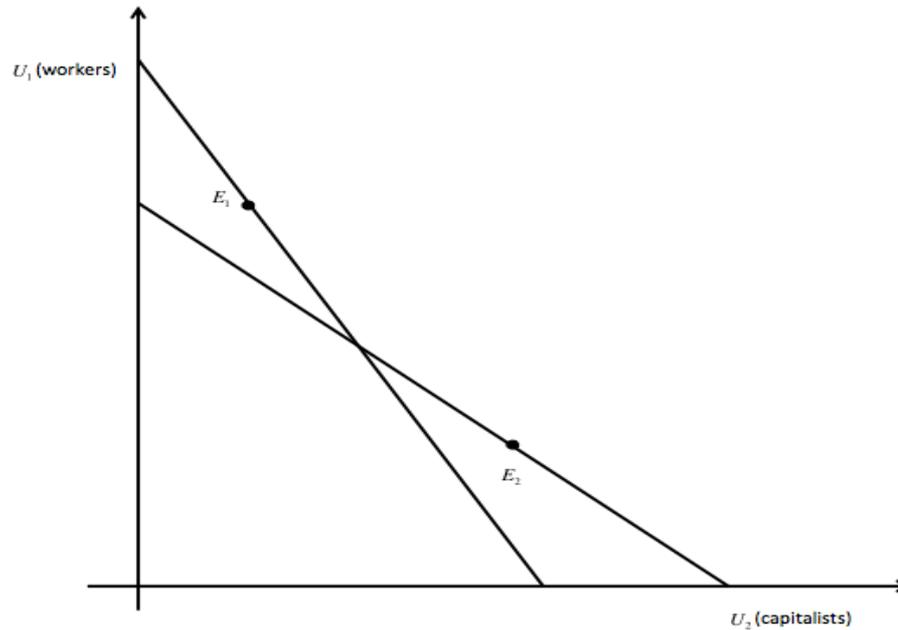
# Limiting case: workerless economy

- Imagine a near workerless economy. Would standards of living collapse? Obviously not necessarily: utility possibility curve has moved out, even if competitive equilibrium wage has decreased
- Redistribution (or change in intellectual property rights) would ensure that everyone could be made better off
- If redistribution (changes in intellectual property rights) are costly, so workers' couldn't be fully compensated, it implies that "new" utility possibilities schedule does not lie outside the other, taking into account costs of redistribution
  - Public policy may act to limit change

# With redistribution, all groups could be made better off



# Technological advance not Pareto improvement



# Critical question: public policy

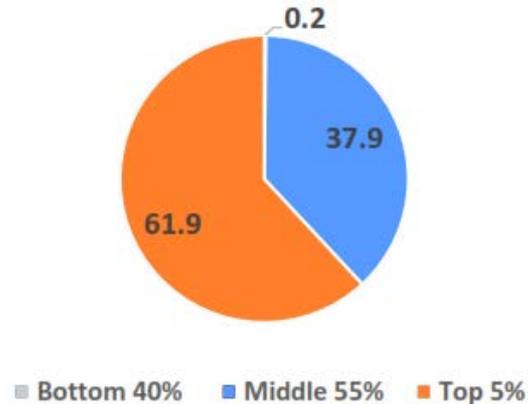
- Are there public policies which would ensure that everyone would be better off?
- Political economy: will these policies emerge out of our political processes?

The remainder of this lecture focuses on first question.

Constructs a simple model

## Stylized facts on wealth inequality

### U.S. wealth is very unequally distributed



### Distinct characteristics of cohorts

- **Saving motive:** wealthy households  $\Rightarrow$  dynastic, poorer households  $\Rightarrow$  life-cycle (Attanasio, 1994; Dynan et al., 2004; Browning and Lusardi, 1996).
- **Income source:** share of labor income decreases with income (Quadrini, 1997; Diaz-Gimenez et al., 2011; Wolff, 1998).
- **Patience:** time preference rate decreases with wealth (Lawrance, 1991; Green et al., 1996; Saez & Zucman, 2016).

## Model: Overview

- General equilibrium growth model with two household types.
  - **Capitalists:** saving dynastically, only income source is capital
  - **Workers:** mostly labor income, of which they save for retirement
- Standard neoclassical production side
- Government levies capital tax to finance productive public investment
- Focus both on workers' life time income and wealth distribution (life cycle capital relative to total capital)

# Productive investments vs. redistribution

- Earlier result (Stiglitz, 2015): government levies capital tax used to redistribute income
- Decline in wages more than offsets transfer payments
- Workers worse off, even if relative holdings of capital increase

## Capitalists

$$\max_{C^c, K^c} \sum_{t=0}^{\infty} \frac{1}{(1 + \rho_c)^t} \ln(C_t^c), \quad (1)$$

subject to

$$K_{t+1}^c - K_t^c = (1 - \tau)r_t K_t^c - C_t^c. \quad (2)$$

Solving the maximization problem yields the Euler equation

$$\frac{C_{t+1}^c}{C_t^c} = \frac{1 + (1 - \tau)r_{t+1}}{1 + \rho_c}. \quad (3)$$

...where:  $K_t^c$ : capitalist's capital stock,  $C_t^c$ : capitalist's consumption,  $\rho_c$ : capitalist's time preference rate,  $r_t$ : interest rate,  $\tau$ : the capital tax rate.

## Workers

live for two periods, a 'young' (y) and an 'old' (o) stage.

$$\max_{C_t^y, C_t^o, S_t} \ln(C_t^y) + \frac{1}{1 + \rho_w} \ln(C_{t+1}^o). \quad (4)$$

subject to

$$w_t L = S_t + C_t^y \quad \text{and} \quad (5)$$

$$C_{t+1}^o = (1 + (1 - \tau)r_{t+1})S_t. \quad (6)$$

Solving the optimization problem subject to the budget constraints leads to the Euler equation:

$$\frac{C_{t+1}^o}{C_t^y} = \frac{1 + (1 - \tau) \cdot r_{t+1}}{1 + \rho_w}. \quad (7)$$

...where:  $S_t$ : workers' capital stock,  $C_t^y, C_t^o$ : workers' consumption when young and old,  $\rho_w$ : workers' time preference rate,  $r_t$ : interest rate,  $w_t$ : wage rate,  $L$ : labor (fixed),  $\tau$ : capital tax rate.

## Production and government

The firm produces output according to a neoclassical constant returns production function

$$Q = F(P, K, L)$$

The government provides public capital and finances its investments by the capital tax:

$$P_{t+1} = (1 - \delta_P)P_t + \tau r_t K_t. \quad (8)$$

# Labor productivity increasing public investment

Assume output is a CRTS function of private capital and effective labor  $J$

$$Q = F(K, J)$$

Where

$$J = J(L, P) = L j(k_g)$$

Where  $k_g$  is human capital per worker,  $k_g = P/L$

## Production and government

CES production function :

$$F(P_t, K_t, L) = (\alpha K_t^\gamma + (1 - \alpha)(P_t^\beta L^{(1-\beta)})^\gamma)^{\frac{1}{\gamma}},$$

$0 < \alpha, \beta < 1$  and  $K_t = K_t^c + S_{t-1}$ .

- Assume  $\alpha + \beta < 1$  (exclude long-run explosive growth)
- Assume  $\gamma < 1, \gamma \neq 0$ .
- Elasticity of substitution btw. capital and labor  $\sigma$  is given by  $\sigma = 1/(1 - \gamma)$ .

## Steady State

The economy converges to a steady state. There the interest-rate depends *only* on capitalists' behavior:

$$\tilde{r} = \frac{\rho_c}{(1 - \tau)} \quad (9)$$

and

$$\frac{\tilde{S}}{\tilde{K}} = \frac{1}{2 + \rho_w} \frac{wL}{\tilde{K}}. \quad (10)$$

### Implications

- Pasinetti (1962) Theorem: The capitalists determine the interest rate – and hence the size of the stock of private capital.
- The workers determine the distribution of capital.

# Steady state

- $P = \tau r K / \delta$

So equilibrium  $K$  can be written just as a function of  $\tau$ :  $K = \varphi(\tau)$

$$F_2(\tau r K / \delta, K, L)(1 - \tau) = F_2(\tau \rho_c K / \delta(1 - \tau), K, L)(1 - \tau) = \rho_c$$

Where

$$F_1(\tau r K / \delta, K, L) = r = \rho_c / (1 - \tau).$$

Workers' welfare can be written as

$$V = k + [(2 + \rho_w) / (1 + \rho_w)] \ln w$$

# Workers income

- Depends on who appropriates returns from public capital
- Assume that public capital is spent on education
- Natural implication: workers appropriate it as return on their labor

Then

Worker's income  $w = F_3 + F_1P = w(\tau)$ .

The objective is to find capital tax rate that maximizes worker's well being, i.e. find  $\tau$  for which  $w'(\tau) = 0$ .

*If public capital and labor are complements,  $F_{31} > 0$  (as we would expect for education), then it is easy to show that  $\tau^* > 0$ .*

# Special case

- $Q/J = f(k)$  where  $k = K/J$

Implying  $f'(k) (1 - \tau) = \rho_c$

Implying  $k = f'^{-1}(\rho_c / (1 - \tau)) = k^*(\tau)$

And workers income =  $J(f(k^*(\tau)) - f'k)$

Where normalizing at  $L = 1$ ,  $J = j (\tau K \rho_c / (1 - \tau)) = K/k^*(\tau)$

Which can be solved for  $K = K^*(\tau)$  and  $J^*(\tau)$ ,

Including the value of  $\tau$  which maximizes  $J$ .

# Workers' well-being and inequality

- An increase in workers income increases  $S$ , workers' wealth
- Typically, an increase in  $\tau$  reduces  $K$ , capitalists' wealth
- At  $\tau^*$ , further (slight) increases in  $\tau$  reduce inequality, but are still undesirable: we should focus on worker well-being, not inequality
- At high enough  $\tau$  (may be above or below  $\tau^*$ ) under quite general conditions,  $S/K = 1$  (capitalists can't co-exist)
  - Generalizing result originally due to Pasinetti (1962) (See also Modigliani and Samuelson 1966 and Stiglitz 1967)

## Wealth inequality: an explicit characterization

For the CES, one can derive that

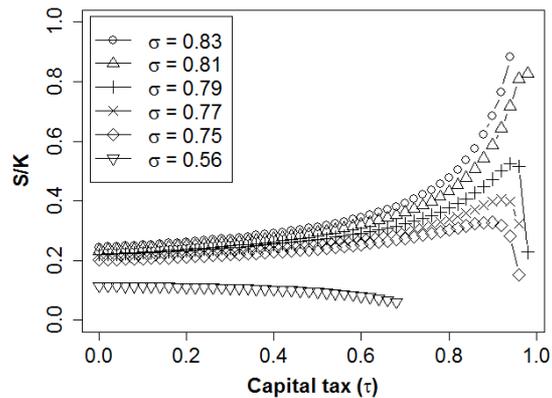
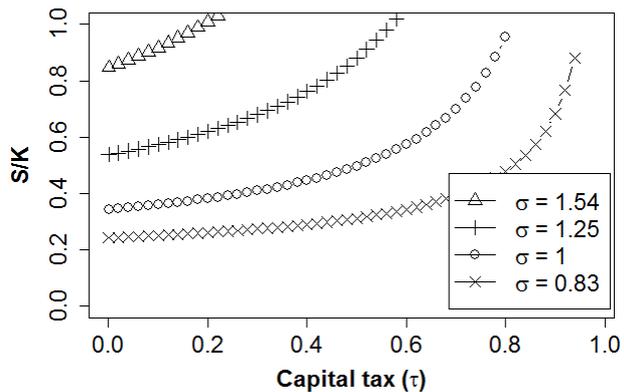
$$\frac{\tilde{S}}{\tilde{K}}(\tau; \gamma) = \frac{(1 - \alpha)}{\alpha(2 + \rho_w)} \left( \frac{\rho_c}{1 - \tau} + \delta_k \right) \left( \frac{1}{(1 - \alpha)} \left( \frac{1}{\alpha} \left( \frac{\rho_c}{1 - \tau} + \delta_k \right) \right)^{\frac{\gamma}{1 - \gamma}} - \alpha \right).$$

### Three regimes

- $0 < \frac{\tilde{S}}{\tilde{K}}(\tau; \gamma) < 1$ : **Pasinetti (1962)-regime**: classes co-exist.
- $\frac{\tilde{S}}{\tilde{K}}(\tau; \gamma) = 1$ : **Anti-Pasinetti-regime**: capitalists extinct. Samuelson and Modigliani (1966)
- $\frac{\tilde{S}}{\tilde{K}}(\tau; \gamma) = 0$ : **Anti-Anti-Pasinetti regime**: workers extinct.

**How do these regimes depend on the policy intervention and the production function parameters ("automation?")**

# Main result: It depends on the elasticity



## Main result: Threshold elasticity

### Theorem

*Let production be specified as above.*

- a) There exists  $\sigma_1 < 1$ , such that:  $\sigma > \sigma_1$ , for every  $\sigma$ , there exists a capital tax rate, such that capitalists vanish (**Anti-Pasinetti** case).
- b) The relationship is monotone: the higher the elasticity, the lower the tax rate extinguishing capitalists.

## Intuitions

- Capital taxes that finance labor-enhancing public investment influence the relative importance of capital and labor:
- For high elasticities, workers earn more and can afford to save more.
- For low elasticities, *beyond a point*, the higher the tax rate, the cheaper labor becomes relative to capital, which suppresses wages and decreases workers' wages and savings.

# Concluding comments

- Analysis reminds us that policies focusing on inequality should focus not just on redistribution, but on the distribution of income and wealth
- In the case where elasticity of substitution is low, government investment should be directed at capital-enhancing investments, which will drive down the return to capital and increase that of labor
- In general, there is an optimal allocation of public investment between labor enhancing and capital enhancing
- Government policies may also affect the elasticity of substitution
- Through pre- and re-distribution, technological advances *should* enable us to improve well-being of everyone
  - Even the challenge of finding meaningful work for everyone can be met

# Conditions under which evolution of technology is likely to be welfare increasing

- Economy will be evolving towards service sector economy
- Among key service sectors are education, health, and other public services
- Value of those services is largely socially determined—not “just” a market process
- If we value those services highly—pay good wages, provide good working conditions, and create sufficient number of jobs—that will limit growth in market income inequality
  - Including jobs with limited skill requirements
  - Higher pay will result in such jobs having higher “respect”
  - Private sector wages will follow public sector wages
  - May need also to provide wage subsidy for low wage jobs, to encourage demand for such jobs and increase wages
- If elasticity of entrepreneurial services is low, we can impose high taxes to finance these jobs
- Optimal IPR regime (with taxes) can ensure benefits of innovation are shared
- If endogenously determined bias of technological change works as it should, as wages get low, focus is on capital and resource augmenting technical change
  - Limiting decline in share of labor (in stable equilibrium) and in inequality

- Under these conditions, benefits of growth can be shared equitably, and in ways that ensure full employment
  - Larger pie—so everyone can be better off
- Such an outcome is economically feasible
- But economy may not go in that direction
  - Politics matters