Intergenerational Bargaining in Technology Adoption

Byeongju Jeong

Motivating Examples

Transition of communist countries in 1980/90's

The aftermath of the Asian crisis in late 1990's

China vs Europe in the 16th - 19th centuries

Literature

Krusell and Rios-Rull (1996):

Vintage Capital vs Matching

Voting vs Bargaining

The Basic Model

The old generation

$$V_o(h) = \max\{\phi h, h - w(h)\}$$

The young generation

$$V_y(h) = w(h) + \beta V_o(h)$$

$$\tilde{V}_y = \int (\theta h + \beta V_o(h))\, dF(h)$$

Frictionless matching

$$V_y(h) = \tilde{V}_y$$

Payment schedule

$$w(\bar{h}) = (1 - \phi) \cdot \bar{h}$$

$$w(h) = w(\bar{h}) - \frac{\beta(h - \bar{h})}{1 - \beta}$$

Evolution of human capital distribution

$$G'(h) = G(\bar{h}) \cdot F(h) \quad \text{for } h < \bar{h}$$

$$G'(h) = G(\bar{h}) \cdot F(h) + G(h) - G(\bar{h}) \quad \text{for } h \geq \bar{h}$$

Technology Adoption

$$\hat{F}\text{: new; } \check{F}\text{: old; } \tilde{F}\text{: used}$$

$$S \equiv (\hat{F}, \check{F}, G);\ \tilde{S} \equiv (S, \tilde{F})$$

$$\Gamma(S) = \begin{cases} \hat{F} & \text{in case of adoption} \\ \check{F} & \text{in case of conservation} \end{cases}$$

$$V_o(h; \tilde{S}, \Gamma) = \max\left\{\phi h, h - w(h; \tilde{S}, \Gamma)\right\}$$

$$V_y(h; \tilde{S}, \Gamma) = w(h; \tilde{S}, \Gamma) + \beta V_o(h; \Lambda\tilde{S}(\tilde{S}, \Gamma), \Gamma)$$

$$\tilde{V}_y(\tilde{S}, \Gamma) = \int \left(\theta h + \beta V_o(h; \Lambda\tilde{S}(\tilde{S}, \Gamma), \Gamma)\right) d\tilde{F}(h)$$

$$\Lambda S(\tilde{S}, \Gamma) \equiv (\Lambda\hat{F}, \tilde{F}, \Lambda G(\tilde{S}, \Gamma)$$

$$\Lambda\tilde{S}(\tilde{S}, \Gamma) \equiv (\Lambda S(\tilde{S}, \Gamma), \Gamma(\Lambda S(\tilde{S}, \Gamma)))$$

Efficient Bargaining

$$\Gamma(S) = \arg\max_{\tilde{F}} \left\{\tilde{V}_y(\tilde{S}, \Gamma) + \int V_o(h; \tilde{S}, \Gamma) dG(h)\right\}$$

One New Technology: Institutional Change

$$\Lambda\hat{F}(h) = \hat{F}(h)$$

Consider: $\Gamma(\Lambda S(\check{S},\Gamma)) = \hat{F}$

$$\begin{aligned}\Delta\tilde{V}_y(S,\Gamma) &\equiv \tilde{V}_y(\hat{S},\Gamma) - \tilde{V}_y(\check{S},\Gamma)\\ &= (1-\phi+\beta\phi)(\bar{h}(\hat{S},\Gamma) - \bar{h}(\check{S},\Gamma))\end{aligned}$$

$$\begin{aligned}\Delta V_o(S,\Gamma) &\equiv \int \Big(V_o(h;\check{S},\Gamma) - V_o(h;\hat{S},\Gamma)\Big)\, dG(h)\\ &= \Delta\tilde{V}_y(S)\tilde{G}(\bar{h}(\check{S},\Gamma),\bar{h}(\hat{S},\Gamma))\end{aligned}$$

$$\tilde{G}(h_1,h_2) \equiv 1 - G(h_2) + \int_{h_1}^{h_2} \frac{h-h_1}{h_2-h_1} dG(h)$$

$$\Delta\tilde{V}_y(S,\Gamma) > \Delta V_o(S,\Gamma)$$

An equilibrium is: $\Gamma(S) = \hat{F}$ for all S

One New Technology: Institutional Change

$$\Lambda\hat{F}(h) = \hat{F}(h)$$

Consider: $\Gamma(\Lambda^t S(\check{S}, \Gamma)) = \check{F}$

$$\Delta\tilde{V}_y(S) = (1 - \phi + \beta\phi)(\bar{h}(\hat{S}, \Gamma) - \bar{h}(\check{S}, \Gamma))$$

$$\Delta V_o(S, \Gamma) = \frac{\Delta\tilde{V}_y(S)\tilde{G}(\bar{h}(\check{S}, \Gamma), \bar{h}(\hat{S}, \Gamma))}{1 - \beta}$$

$$\Delta V_o(S, \Gamma) > \Delta\tilde{V}_y(S, \Gamma) \text{ if } \tilde{G}(\bar{h}(\check{S}, \Gamma), \bar{h}(\hat{S}, \Gamma)) > 1 - \beta$$

Assume:

$$\tilde{G}(\bar{h}((\Lambda S(\check{S}, \Gamma), \check{F}), \Gamma), \bar{h}((\Lambda S(\check{S}, \Gamma), \hat{F}), \Gamma) > 1 - \beta$$
$$\text{if } \tilde{G}(\bar{h}(\check{S}, \Gamma), \bar{h}(\hat{S}, \Gamma)) > 1 - \beta$$

Then, an equilibrium is:

$$\Gamma(S) = \begin{cases} \hat{F} & \text{if } \tilde{G}(\bar{h}(\check{S}, \Gamma), \bar{h}(\hat{S}, \Gamma)) \leq 1 - \beta \\ \check{F} & \text{if } \tilde{G}(\bar{h}(\check{S}, \Gamma), \bar{h}(\hat{S}, \Gamma)) > 1 - \beta \end{cases}$$

Exogenous Technological Change: Decentral Policy Making

$$\Lambda\hat{F}(h) = \hat{F}(h/\lambda)$$

Consider: $\Gamma(\Lambda^t S(\hat{S},\Gamma)) = \Gamma(\Lambda^t S(\check{S},\Gamma)) = \Lambda^t \hat{F}$

$$\Delta\tilde{V}_y(S,\Gamma) = (1-\phi+\beta\phi)(\bar{h}(\hat{S},\Gamma) - \bar{h}(\check{S},\Gamma))$$

$$\Delta V_o(S,\Gamma) = \Delta\tilde{V}_y(S)\tilde{G}(\bar{h}(\check{S},\Gamma), \bar{h}(\hat{S},\Gamma))$$

$$\Delta\tilde{V}_y(S,\Gamma) > \Delta V_o(S,\Gamma)$$

An equilibrium is: $\Gamma(S) = \hat{F}$ for all S

Consider: $\Gamma(S) = \Gamma(\Lambda^t S(\check{S},\Gamma)) = \check{F}$

$$\tilde{V}_y((\Lambda^t S(\check{S},\Gamma), \Lambda^t \hat{F}), \Gamma) \geq \int h(\theta+\beta\phi) d\Lambda^t \hat{F}(h)$$

$$\Delta\tilde{V}_y(\Lambda^t S(\check{S},\Gamma),\Gamma) > \Delta V_o(\Lambda^t S(\check{S},\Gamma),\Gamma)$$

for some t

Not an equilibirum for any S:

$\Gamma(S) = \Gamma(\Lambda^t S(\check{S},\Gamma)) = \check{F}$ for all t

Endogenous Technological Change: Central Policy Making

$$\Lambda F(h) = \tilde{F}(h/\lambda)$$

Consider: $\Gamma(\Lambda^t S(\hat{S},\Gamma)) = \Lambda^t \hat{F}$; $\Gamma(\Lambda^t S(\check{S},\Gamma)) = \Lambda^{t-1}\hat{F}$

$$\Delta\tilde{V}_y(S,\Gamma) = (1-\phi+\beta\phi)(\bar{h}(\hat{S},\Gamma) - \bar{h}(\check{S},\Gamma))$$

$$\Delta V_o(S,\Gamma) = \Delta\tilde{V}_y(S)\breve{G}(\bar{h}(\check{S},\Gamma),\bar{h}(\hat{S},\Gamma))$$

$$\breve{G}(h_1,h_2) \equiv \tilde{G}(h_1,h_2) + \frac{\beta(\lambda-1)h_2}{h_2-h_1}$$

$$\times \sum_{t=0}^{\infty}\left\{\int_{\lambda^t h_2}^{\lambda^{t+1}h_2}\left(\frac{1-\lambda^t\beta^t}{1-\lambda\beta} + \frac{\lambda^t\beta^t(h-\lambda^t h_2)}{\lambda^{t+1}h_2-\lambda^t h_2}\right)dG(h)\right\}$$

$$\Delta\tilde{V}_y(S,\Gamma) > \Delta V_o(S,\Gamma) \text{ if } G(\bar{h}(\check{S},\Gamma),\bar{h}(\hat{S},\Gamma)) < 1$$

Not an equilibrium: $\Gamma(S) = \hat{F}$ for all S

Endogenous Technological Change: Central Policy Making

$$\Lambda F(h) = \tilde{F}(h/\lambda)$$

Consider: $\Gamma(\Lambda^t S(\hat{S}, \Gamma)) = \hat{F}$; $\Gamma(\Lambda^t S(\check{S}, \Gamma)) = \check{F}$

$$\Delta \tilde{V}_y(S) = (1 - \phi + \beta\phi)(\bar{h}(\hat{S}, \Gamma) - \bar{h}(\check{S}, \Gamma))$$

$$\Delta V_o(S, \Gamma) = \frac{\Delta \tilde{V}_y(S) \tilde{G}(\bar{h}(\check{S}, \Gamma), \bar{h}(\hat{S}, \Gamma))}{1 - \beta}$$

$$\Delta V_o(S, \Gamma) > \Delta \tilde{V}_y(S, \Gamma) \text{ if } \tilde{G}(\bar{h}(\check{S}, \Gamma), \bar{h}(\hat{S}, \Gamma)) > 1 - \beta$$

Not an equilibrium: $\Gamma(S) = \check{F}$ for all S

Endogenous Technological Change: Central Policy Making

$$\Lambda F(h) = \tilde{F}(h/\lambda)$$

Consider: $\Gamma(\Lambda^t S(\hat{S},\Gamma)) = \Lambda^t \hat{F}$; $\Gamma(\Lambda^t S(\check{S},\Gamma)) = \check{F}$

$$\Delta\tilde{V}_y(S,\Gamma) = (1-\phi+\beta\phi)(\bar{h}(\hat{S},\Gamma) - \bar{h}(\check{S},\Gamma))$$

$$\Delta V_o(S,\Gamma) = \frac{\Delta\tilde{V}_y(S)\breve{G}(\bar{h}(\check{S},\Gamma),\bar{h}(\hat{S},\Gamma))}{1-\beta}$$

$$\Delta V_o(S,\Gamma) > \Delta\tilde{V}_y(S,\Gamma) \text{ if } \breve{G}(\bar{h}(\check{S},\Gamma),\bar{h}(\hat{S},\Gamma)) > 1-\beta$$

Assume:

$$\breve{G}(\bar{h}((\Lambda S(\hat{S},\Gamma),\hat{F}),\Gamma),\bar{h}((\Lambda S(\hat{S},\Gamma),\Lambda\hat{F}),\Gamma)) \le 1-\beta$$
$$\text{if } \breve{G}(\bar{h}(\check{S},\Gamma),\bar{h}(\hat{S},\Gamma)) \le 1-\beta;$$

$$\breve{G}(\bar{h}((\Lambda S(\check{S},\Gamma),\check{F}),\Gamma),\bar{h}((\Lambda S(\check{S},\Gamma),\hat{F}),\Gamma)) > 1-\beta$$
$$\text{if } \breve{G}(\bar{h}(\check{S},\Gamma),\bar{h}(\hat{S},\Gamma)) > 1-\beta$$

Then, an equilibrium is:

$$\Gamma(S) = \begin{cases} \hat{F} & \text{if } \breve{G}(\bar{h}(\check{S},\Gamma),\bar{h}(\hat{S},\Gamma)) \le 1-\beta \\ \check{F} & \text{if } \breve{G}(\bar{h}(\check{S},\Gamma),\bar{h}(\hat{S},\Gamma)) > 1-\beta \end{cases}$$

Generational Transfers

$$V_o(h;\tilde{S},\Gamma) = \max\left\{\phi h, h - w(h;\tilde{S},\Gamma)\right\} + \tau(\tilde{S},\Gamma)$$

$$V_y(h;\tilde{S},\Gamma) = w(h;\tilde{S},\Gamma) + \beta V_o(h;\Lambda\tilde{S}(\tilde{S},\Gamma),\Gamma) - \tau(\tilde{S},\Gamma)$$

$$\tilde{V}_y(\tilde{S},\Gamma) = \int\Big(\theta h + \beta V_o(h;\Lambda\tilde{S}(\tilde{S},\Gamma),\Gamma)\Big)d\tilde{F}(h) - \tau(\tilde{S},\Gamma)$$

$$W_o(h;\tilde{S},\Gamma) \equiv V_o(h;\tilde{S},\Gamma) - \tau(\tilde{S},\Gamma)$$

$$\tilde{W}_y(\tilde{S},\Gamma) \equiv \tilde{V}_y(\tilde{S},\Gamma) + \tau(\tilde{S},\Gamma)$$

Transfer Rule

$$\frac{\tilde{V}_y(\tilde{S},\Gamma) - (\rho\tilde{W}_y(\hat{S},\Gamma) + (1-\rho)\tilde{W}_y(\check{S},\Gamma))}{\int(V_o(h;\tilde{S},\Gamma) - (\rho W_o(h;\hat{S},\Gamma) + (1-\rho)W_o(h;\check{S},\Gamma)))dG(h)} = \frac{\sigma}{1-\sigma}$$

$$\tau(\hat{S},\Gamma) = (1-\rho)\left\{(1-\sigma)\Delta\tilde{W}_y(S;\Gamma) + \sigma\Delta W_o(S;\Gamma)\right\}$$

$$\tau(\check{S},\Gamma) = \quad -\rho \quad \left\{(1-\sigma)\Delta\tilde{W}_y(S;\Gamma) + \sigma\Delta W_o(S;\Gamma)\right\}$$

One New Technology Revisited

$$\begin{aligned}\Delta\tilde{W}_y(S) = &(1-\phi+\beta\phi)(\bar{h}(\hat{S},\Gamma)-\bar{h}(\check{S},\Gamma)) \\ &+\beta(\tau(\Lambda\tilde{S}(\hat{S},\Gamma))-\tau(\Lambda\tilde{S}(\check{S},\Gamma)))\end{aligned}$$

$$\text{Assume: } \Lambda G(\check{S},\Gamma) = G$$

Consider: $\Gamma(\Lambda S(\check{S},\Gamma)) = \hat{F}$

$$\Delta\tilde{V}_y(S,\Gamma) > \Delta V_o(S,\Gamma) \text{ if } \tilde{G}(\bar{h}(\check{S},\Gamma),\bar{h}(\hat{S},\Gamma)) \leq \frac{1}{1+\beta(1-\rho)}$$

Consider: $\Gamma(\Lambda^t S(\check{S},\Gamma)) = \check{F}$

$$\Delta V_o(S,\Gamma) > \Delta\tilde{V}_y(S,\Gamma) \text{ if } \tilde{G}(\bar{h}(\check{S},\Gamma),\bar{h}(\hat{S},\Gamma)) > \frac{1-\beta}{1-\beta\rho}$$