Aid, growth, and welfare in an interdependent world economy

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CONTENTS

Does aid raise growth?

Yes! Burnside and Dollar (2000, AER)

"aid would be more effective if it were more systematically conditioned on good policy."(p. 847)

Really? Easterly (2003, JEP)

"The empirical literature ... has been hampered by the lack of a clear theoretical model by which aid would influence growth and which could pin down the empirical specification of the aid-growth relationship."(p. 30)

We meet this demand for a theory of aid and growth.

Theoretical literature on aid and growth

- Chatterjee et al. (2003, EER)
  - small open recipient country
  - one good
  - public and private capital
- Chatterjee and Turnovsky (2005, RIE)
  - + nonunitary elasticity of factor substitution
- Chatterjee and Turnovsky (in press, JDE)
  - + labor-leisure choice

Result: only tied aid for pub. inv. raises long-run growth

Overlooked aspects of foreign aid

- Why do donors give aid?
  aid should be Pareto-improving:
  - Galor and Polemarchakis (1987, RES): OLG
  - Djajić et al. (1999, EJ): two-period
  - Chao and Yu (1999, JDE): pollution
  - Lahiri et al. (2002, JDE): tariff war
- aid $\rightarrow$ terms of trade $\rightarrow$ growth
  - This paper: aid $\rightarrow$ TOT: core effect in static transfer literature
    - Brakman and van Marrewijk (1998)
  - TOT $\rightarrow$ growth: through incentives to invest
    - De Long and Summers (1991, QJE)
    - Eaton and Kortum (2001, EER)

Framework

two-country, two-good extension of Arrow-Romer model with learning by doing and knowledge spillovers

- two-good models with intersectoral spillovers:
  - Naito (2006, JPubE)
  - Ohdoi (2007, JER): Barro-type public services

advantages:

- constant returns to capital
- only one state variable for each country
- factor price equalization

→ no transitional dynamics!!

Results

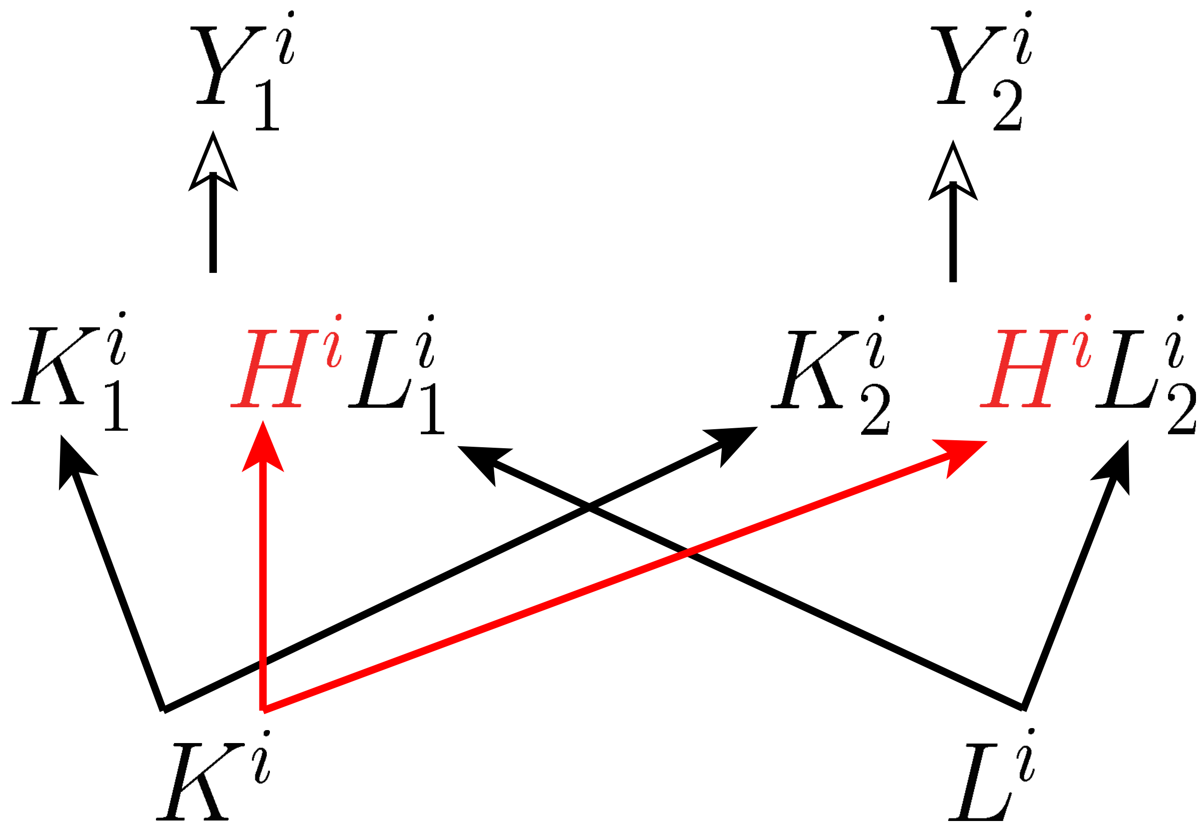
- untied aid $\uparrow \rightarrow$ growth $\uparrow$
  $\Leftrightarrow$ propensity to consume capital-intensive good:

  $$\text{recipient} > \text{donor}$$

  $\because$ aid $\uparrow$
  $\rightarrow$ price of capital-intensive good $\uparrow$
  $\rightarrow$ returns to capital $\uparrow$($\because$ Stolper-Samuelson theorem)
- growth-enhancing aid is also Pareto-improving
  $\Leftrightarrow$ PTCs are sufficiently different between countries;
  subjective discount rate $\downarrow \rightarrow$ required difference $\downarrow$
  $\because$ dynamic welfare gains > static welfare losses

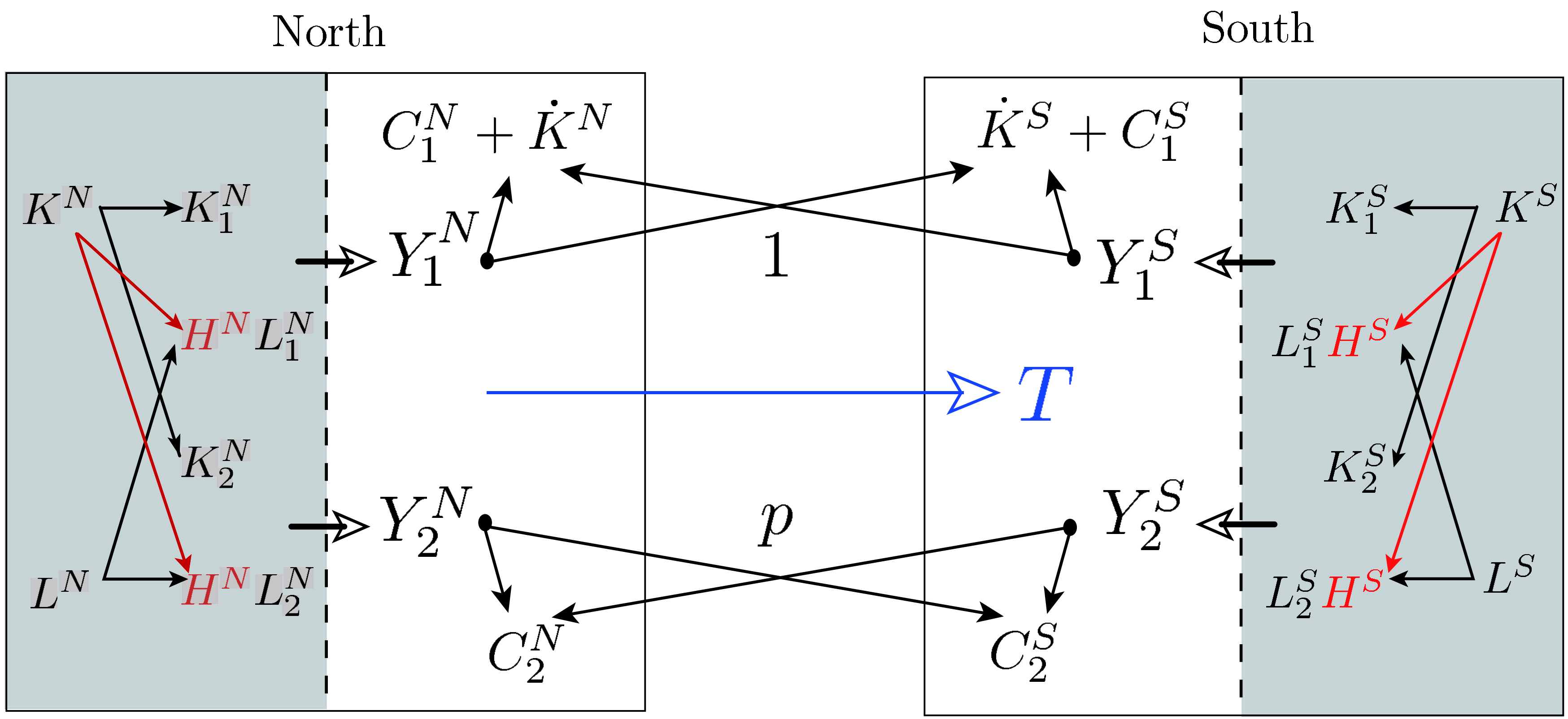
$2 \times 2 \times 2$ model with LBD and intersectoral spillove

LBD and intersectoral spillovers:



$2 \times 2 \times 2$ model with LBD and intersectoral spillove

Two country:



Firms

Production tech.: $Y_j^i = F(K_j^i, H^i L_j^i)$; $\quad H^i = h^i K^i (h^i > 0)$.

Def: $v^i \equiv w^i / H^i, H_j^i \equiv H^i L_j^i$

$$\Downarrow$$

$$\begin{aligned} \min_{K_j^i, H_j^i} \quad & r^i K_j^i + v^i H_j^i, \\ \text{s.t.} \quad & Y_j^i = F_j(K_j^i, H_j^i), \\ \text{given} \quad & r^i, v^i. \end{aligned}$$

$$\therefore \quad p_j = c_j(r^i, v^i).$$

Households

$$\max \quad U^i = \int_0^\infty \frac{(C_t^i)^{1-\theta} - 1}{1-\theta} \exp(-\rho t) dt, C_t^i = V^i(C_{1t}^i, C_{2t}^i),$$

$$\text{s.t.} \quad \dot{K}_t^i = (r_t^i - \delta)K_t^i + v_t^i H_t^i + T_t^i - C_{1t}^i - p_t C_{2t}^i$$

$$= (r_t^i - \delta)K_t^i + \color{red}{v_t^i H_t^i} + T_t^i - e^i(p_t)C_t^i; \quad \dot{K}_t^i \equiv dK_t^i/dt,$$

$$\text{given} \quad K_0, \{p_t^i, r_t^i, v_t^i, \color{red}{H_t^i}\}_{t=0}^\infty.$$

FOCs:

$$(C_t^i)^{-\theta} - \lambda_t^i e^i(p_t) = 0$$

$$\lambda_t^i (r_t^i - \delta) = \rho \lambda_t^i - \dot{\lambda}_t^i.$$

$\text{Def} : \color{red}{X} \equiv e(p)^{1/\theta} C \quad \Rightarrow$ K-R rule: $\dfrac{\dot{X}_t^i}{X_t^i} = \dfrac{1}{\theta}(r_t^i - \delta - \rho).$

Equilibrium

FPE: $r^i = r(p), v^i = v(p) \forall i.$

$\Rightarrow$ Dyanmics of X : $\dot{X}_t^i / X_t^i = (1/\theta)(r(p_t) - \delta - \rho) \forall i$

$\Rightarrow X_t^S / X_t^N = \beta \forall t \geq 0.$

Dyanmics of K : $\dot{K}_t^i = (g^i(p_t) - \delta) K_t^i + T_t^i - e^i(p_t)^{1-1/\theta} X_t^i;$

$g^i(p_t) \equiv r(p_t) + v(p_t) h^i.$

Untied Aid: $T_t^N = -T_t, \quad T_t^S = T_t; \quad T_t = \tau K_t^N.$

Market-clearing Condition for Good 2:

$$e_p^N(p_t) e^N(p_t)^{-1/\theta} X_t^N + e_p^S(p_t) e^S(p_t)^{-1/\theta} X_t^S = g_p^N(p_t) K_t^N + g_p^S(p_t) K$$

Solve for $\{X_t^N, X_t^S, K_t^N, K_t^S, p_t\}_{t=0}^{\infty}.$

Solving strategy

We solve our model by taking the following steps:

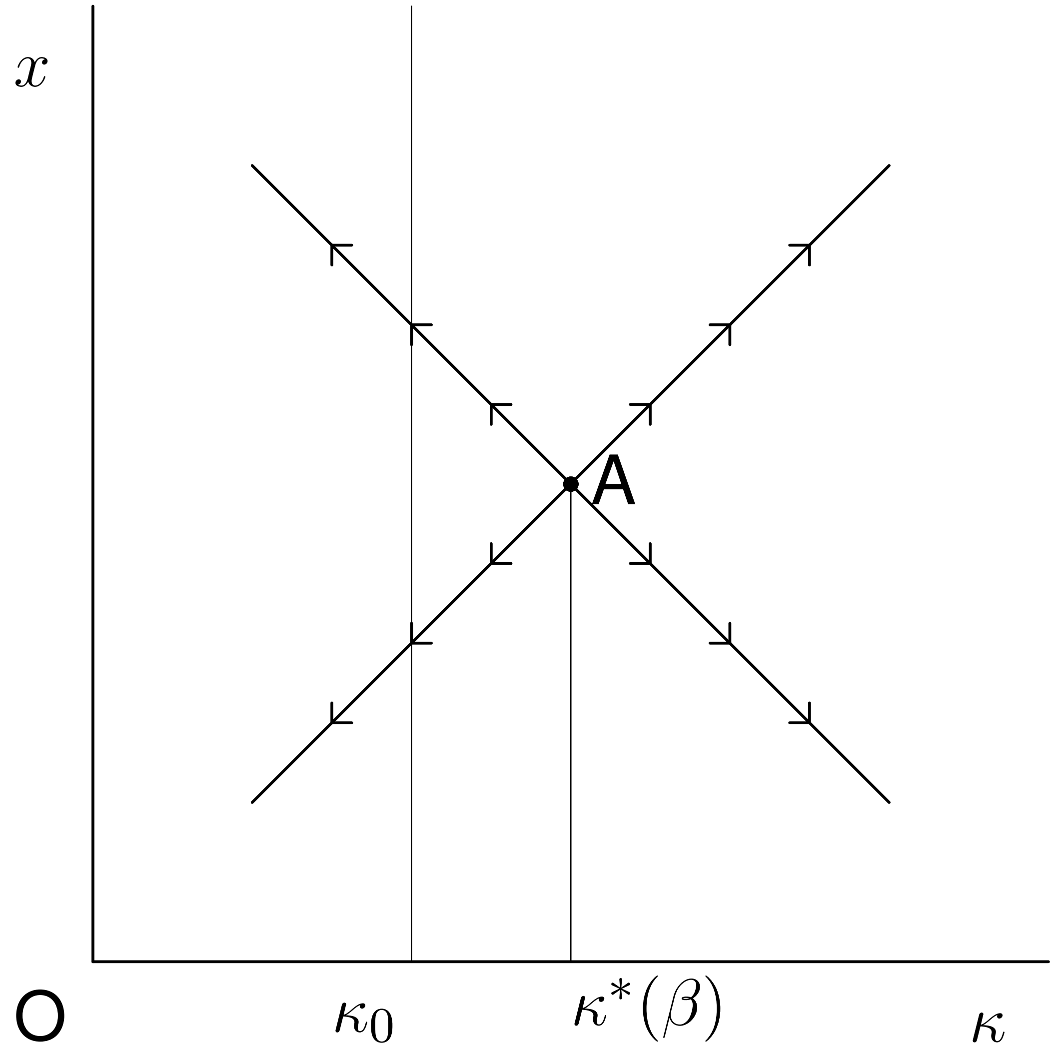
Step 1 Noting that $X_t^S/X_t^N = \beta \forall t$, derive a three-dimensional dynamic system for $x_t \equiv X_t^N/K_t^N, \kappa_t \equiv K_t^S/K_t^N$, and p_t.

Step 2 With β given, characterize the conditions for the unique existence of the steady state with incomplete specialization.

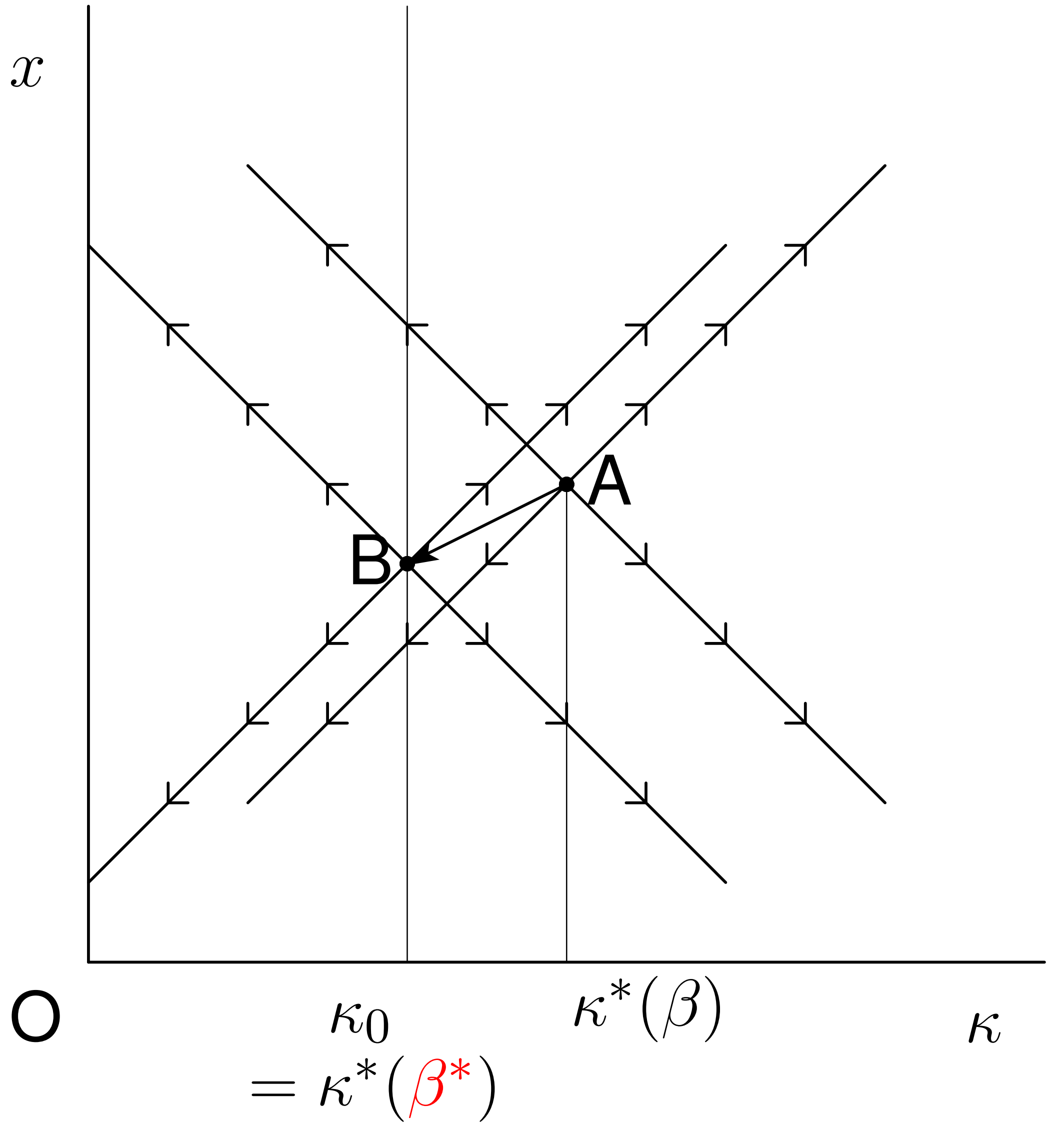
Step 3 With β given, clarify the stability of dynamic system.

Step 4 Determine β: i.e., the initial level of consumption in country S.

Steady state and stability



Determination of β



Determination of β (Cont'd)

Choose β such that $\kappa^*(\beta^*) = \kappa_0$
$\kappa^*(\beta)$ is monotonic $\Rightarrow \beta^* = (\kappa^*)^{-1}(\kappa_0)$ is unique

$$\therefore (x_t, \kappa_t, p_t) = (x^*(\beta^*), \kappa^*(\beta^*), p^*(\beta^*)) \forall t.$$

$$\Downarrow$$

Proposition 1 $\kappa^*(\beta)$ is monotonically increasing
$\Rightarrow \exists$ unique incomplete specialization equilibrium,
in which the world economy is always in the steady state.

Intuition (e.g., Chen, 1992, CJE):

factor price equalization $\rightarrow$ same incentives to invest

Restatement of our model

$$\gamma(p) \equiv \frac{1}{\theta}(r(p) - \delta - \rho).$$

$$\begin{aligned}
\gamma(p)K^N + \delta K^N + e^N(p)C^N &= g^N(p)K^N - T, \\
\gamma(p)K^S + \delta K^S + e^S(p)C^S &= g^S(p)K^S + T, \\
e_p^N(p)C^N + e_p^S(p)C^S &= g_p^N(p)K^N + g_p^S(p)K^S.
\end{aligned}$$

- p, C^N, C^S are endogenous; K^N, K^S are predetermined
- p is constant over time ($\because$ K^i, C^i, T all grow at the rate $\gamma(p)$)
- same as standard static transfer model, except investment

Effect of aid on p

$$
\begin{aligned}
e^N dC^N &= -dT - (e_p^N C^N - g_p^N K^N)dp - \gamma' K^N dp, \\
e^S dC^S &= \quad dT \quad - (e_p^S C^S - g_p^S K^S)dp - \gamma' K^S dp.
\end{aligned}
$$

terms of trade effect   growth effect

$$
\begin{aligned}
0 &= \Delta dp + (b_2^S - b_2^N)dT; \\
b_2^i &\equiv C_2^i / E^i = e_p^i / e^i, \\
\Delta &\equiv e_{pp}^N C^N - g_{pp}^N K^N + e_{pp}^S C^S - g_{pp}^S K^S - \sum_i b_2^i (e_p^i C^i - g_p^i K^i + \gamma' K^i) \\
&< 0 \Leftrightarrow d\kappa^* / d\beta > 0.
\end{aligned}
$$

$$
\therefore \quad \frac{dp}{dT} = \frac{b_2^N - b_2^S}{\Delta} \left\{ \begin{array}{c} > \\ < \end{array} \right\} 0 \Leftrightarrow b_2^N \left\{ \begin{array}{c} < \\ > \end{array} \right\} b_2^S.
$$

Growth effect

$$\gamma' = \frac{1}{\theta}\frac{dr}{dp} = -\frac{1}{\theta}\frac{a_{H1}}{a}; a \equiv a_{K1}a_{H2} - a_{H1}a_{K2}.$$

$$\therefore \quad \gamma' \left\{ \begin{array}{c} > \\ < \end{array} \right\} 0 \Leftrightarrow a \left\{ \begin{array}{c} < \\ > \end{array} \right\} 0 \Leftrightarrow \frac{a_{K1}}{a_{H1}} \left\{ \begin{array}{c} < \\ > \end{array} \right\} \frac{a_{K2}}{a_{H2}}.$$

Proposition 2 $(b_2^N - b_2^S)/a > 0 \Leftrightarrow$ aid raises growth.

- $b_2^N < b_2^S, a < 0 : T \uparrow \rightarrow p \uparrow \rightarrow r \uparrow$
- $b_2^N > b_2^S, a > 0 : T \uparrow \rightarrow p \downarrow \rightarrow r \uparrow$

i.e., S has larger propensity to consume K-intensive good

Effects of aid on C^N and C^S

$$
\begin{aligned}
e^N dC^N &= -dT - (e_p^N C^N - g_p^N K^N + \gamma' K^N)\frac{b_2^N - b_2^S}{\Delta} dT \\
&= -\frac{1}{\Delta}[\Sigma - b_2^N(e_p^N C^N - g_p^N K^N + \gamma' K^N) - b_2^S(e_p^S C^S - g_p^S K^S + \gamma' K^S) \\
&\quad + (e_p^N C^N - g_p^N K^N + \gamma' K^N)b_2^N - (e_p^N C^N - g_p^N K^N + \gamma' K^N)b_2^S] dT, \\
e^S dC^S &= dT - (e_p^S C^S - g_p^S K^S + \gamma' K^S)\frac{b_2^N - b_2^S}{\Delta} dT \\
&= \frac{1}{\Delta}[\Sigma - b_2^N(e_p^N C^N - g_p^N K^N + \gamma' K^N) - b_2^S(e_p^S C^S - g_p^S K^S + \gamma' K^S) \\
&\quad - (e_p^S C^S - g_p^S K^S + \gamma' K^S)b_2^N + (e_p^S C^S - g_p^S K^S + \gamma' K^S)b_2^S] dT; \\
\Sigma &\equiv e_{pp}^N C^N - g_{pp}^N K^N + e_{pp}^S C^S - g_{pp}^S K^S < 0.
\end{aligned}
$$

- $\gamma' = 0$: same as standard static transfer model
- growth has the opposite effects on C^N and C^S
- $e^N dC^N + e^S dC^S + (K^N + K^S)d\gamma = 0 : \gamma \uparrow \Rightarrow C^i \downarrow$ for some i

Welfare effects

$$C_t^i = C_0^i \exp(\gamma t):$$

$$U^i = \frac{1}{1-\theta}\left[\frac{(C_0^i)^{1-\theta}}{\rho-(1-\theta)\gamma} - \frac{1}{\rho}\right],$$

$$dU^i = \frac{(C_0^i)^{1-\theta}}{\rho-(1-\theta)\gamma}\left[\frac{dC_0^i}{C_0^i} + \frac{d\gamma}{\rho-(1-\theta)\gamma}\right].$$

$$\frac{dC_0^N}{C_0^N} + \frac{d\gamma}{\rho-(1-\theta)\gamma} = \frac{1}{\Delta_0}\left[-\frac{\Sigma_0/K_0^N - b_2^S\gamma'(1+\kappa_0)}{g^N-\delta-\gamma-\tau} + \frac{\gamma'(b_2^N-b_2^S)}{\rho-(1-\theta)\gamma}\right] dT_0,$$

$$\frac{dC_0^S}{C_0^S} + \frac{d\gamma}{\rho-(1-\theta)\gamma} = \frac{1}{\Delta_0}\left[\frac{\Sigma_0/K_0^N - b_2^N\gamma'(1+\kappa_0)}{\kappa_0(g^S-\delta-\gamma)+\tau} + \frac{\gamma'(b_2^N-b_2^S)}{\rho-(1-\theta)\gamma}\right] dT_0.$$

Proposition 3 $[\cdot] < 0 \forall i \Leftrightarrow$ aid raises growth and welfare of both countries.

NOTE: $\rho-(1-\theta)\gamma = r-\delta-\gamma < g^i-\delta-\gamma.$

Conclusions

1. Growth effect of foreign aid is determined by:
   (a) international difference in propensities to consume
   (b) intersectoral factor intensity ranking
2. Aid may raise the growth rate even if it is untied.
3. Economic growth is a mechanism for Pareto-improving aid.