Is migration a good substitute for education subsidies?

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I. Motivation

- **Evidence (incentive hypothesis and brain gain)**
- **Stark and Wang result**
- **Theoretical objective**
- **Empirical objective**

I. Motivation - brain gain hypothesis

- Ex-post, skilled migration reduces human capital accumulation (HCA) in origin countries
- But - Positive effects of skilled migration (remittances, return migration, diaspora externalities)
- But - Ex-ante incentive hypothesis (Mountford, 1997, Vidal, 1998, Stark et al., 1998, Beine et al., 2001): migration prospects increase the expected return to education in poor countries and therefore foster domestic enrollment in education
- Global effect on HCA is ambiguous.

I. Motivation - Evidence on incentive hypothesis

- Anecdotal evidence: choice of major fields of study (medicine, nursing, maritime training) among Filipino students respond to shift in international demand (Lucas, 2004, IOM, 2003)
- Micro studies: Medical doctors working in the UK (Kangasniemi et al. 2004)- 30% of Indian doctors acknowledge that the prospect of emigration affected their effort to put into studies + IT sector in India + Batista et al. (2007) on Cape Verde

I. Motivation - Evidence (incentive hypothesis):

- Macro studies: cross-section empirical studies by Beine et al. (2001, 2003, 2007) - migration prospects have a positive and significant impact on human capital formation. Depending on the magnitude of the migration rate and initial human capital stock, the global response can be positive or negative.
- Mixed effect when using alternative dependent variables (positive with secondary enrolment and literacy rate, depend on specification with tertiary enrolment).
- Panel tests 1975-2000: significant inpact, especially for low-income countries.
- Although causality is hard to establish, positive association between skilled emigration rates and HCA.

I. Motivation - Migration = substitute for subsidies (S-W)

- Skilled migration interacts with local education policies.
- Without migration, an appropriated mix of lump-sum taxes and education subsidies can restore the optimality.
- In a context of beneficial brain drain, Stark and Wang (2002) proned an alternative policy option. Letting a controlled proportion of skilled individuals emigrate to a richer country, the government can reach the socially desirable level of human capital without subsidies.
- The higher the skilled emigration rate, the lower is the rate of subsidy required to decentralize the social optimum $\Longrightarrow$ in the absence of distortion, the emigration policy acts as a perfect substitute for public subsidies.

- First best world (no costs, no distortions)
- Perfect credit markets (no liquidity constraints)
- Homogenous agents: agents have homogenous ability to respond to migration prospects

I. Motivation - Theoretical (normative) objective

Need for a joint analysis of education and emigration policies.
We revisit the optimal migration-subsidy policy mix when social costs and distortions are associated to both instruments

- Fiscal costs (tax evasion, distortive effects on labor supply, exit to the informal sector, administrative costs, or corruption).
- Emigration costs (population growth, ethical opposition, population size acts as a cultural public good, externalities associated to the total stock of human capital).

I. Motivation - Empirical objective

- Empirical relationships between HCA, education subsidies and migration prospects?
- Revisit the brain drain impact on human capital accumulation using simulations?
- Global effect for developing world?

II. Controlling migration as a SB policy option

- **Assumptions**
- **First best world**
- **Second best world**

II. Theory - Assumptions

Small open economy - OLG2 - Homogenous agents - Perfect credit market.
Number of young (N_t), number of adults (A_t), exogenous fertility (n)
Neoclassical technology - Constant world interest rate R:

$$\begin{aligned}
Y_t &= F(K_t, H_t) \equiv H_t f(k_t); \quad k_t = K_t / H_t \\
H_t &= N_t a h_t + A_t h_t = A_t(1+na)h_t \\
k &= f'^{-1}(R) \\
w &= f(k) - kf'(k)
\end{aligned}$$

Due to a technological gap, $w < w^*$ (net of migration costs)
Each worker has an incentive to emigrate to the North.

II. Theory - Assumptions

Risk neutral individuals; utility $U = C^a_{t+1}$; invest e_t in educ when young
Productivity when young: ah_t (h_t = HC of adults)
Productivity when adult $h_{t+1} = e_t^{\alpha} h_t^{\delta}$ (with $\alpha + \delta < 1$)
Probability m_{t+1} of emigrating to the North when adult
Government subsidizes a fraction σ_t of education expenditures
$(n\sigma_t e_t = n\tau_t^y + \tau_t^a)$
Optimal education:

$$\begin{aligned} Max\, E\left(c_{t+1}\right) &= R\left[wah_t - e_t(1-\sigma_t) - \tau_t^y\right] \\ &+ m_{t+1} w^* h_{t+1} + (1 - m_{t+1})\left[wh_{t+1} - \tau^a_{t+1}\right] \end{aligned}$$

Unique and interior solution:

$$e_t = \left[\frac{\alpha h_t^{\delta} \left[w + m_{t+1} (w^* - w) \right]}{R(1 - \sigma_t)} \right]^{\frac{1}{1-\alpha}}$$

Dynamics of human capital

$$h_{t+1} = \left[\frac{\alpha \left[w + m_{t+1} (w^* - w) \right]}{R(1 - \sigma_t)} \right]^{\frac{\alpha}{1-\alpha}} h_t^{\frac{\delta}{1-\alpha}}$$

Unique interior steady state:

$$h_{ss} = \left[\frac{\alpha \left[w + m(w^* - w) \right]}{R(1-\sigma)} \right]^{\frac{\alpha}{1-\alpha-\delta}}$$

When individuals are equally capable of responding to emigration incentives, migration prospects have an unambiguously positive impact on human capital.

Without distortion, public subsidies and a properly controlled emigration policy can be used to reach any level of human capital (see Vidal, 1998, or Stark and Wang, 2002): migration = substitute for subsidies

II. Theory - The first best utilitarian solution

- Government has perfect control on e and m (thought experiment)
- Government concerned by the welfare of remaining residents: Benthamite utiltarian SWF
- Given R, w, A_0, s_0 and h_0, the planner Lagrangian: :

$$\begin{aligned}\ell^{FB} &= \frac{A_0 c_0}{\beta} \\ &+ \sum_{t=0}^{\infty} \beta^t \left\{ A_{t+1} \left[Rwah_t - Re_t + wh_{t+1} \right] + \lambda_t A_{t+1} \left[e_t^{\alpha} h_t^{\delta} - h_{t+1}\right.\right.\end{aligned}$$

First order conditions:

$$\beta^t A_{t+1} w + \beta^{t+1} A_{t+2} Rwa - \beta^t A_{t+1} \lambda_t$$

$$+\beta^{t+1} A_{t+2} \lambda_{t+1} e_{t+1}^{\alpha} \delta h_{t+1}^{\delta-1} = 0 \quad \left(\frac{\partial \ell^{FB}}{\partial h_{t+1}} \right)$$

$$\beta^t A_{t+1} \lambda_t \alpha e_t^{\alpha-1} h_t^{\delta} - \beta^t A_{t+1} R = 0 \quad \left(\frac{\partial \ell^{FB}}{\partial e_t} \right)$$

$$-\beta^t A_t n C_{t+1} < 0 \quad \left(\frac{\partial \ell^{FB}}{\partial m_{t+1}} \right)$$

Proposition 1: Decentralizing the first best solution requires equating the emigration rate to zero, using education subsidies and lump-sum taxes on the young.

Social return on human capital: $\lambda_{ss}^{FB} = \frac{w[1+\beta nRwa]}{1-\beta n\delta} > w$

Long-run level of human capital: $h_{ss}^{FB} = \left[\frac{\alpha w[1+\beta nRwa]}{R[1-\beta n\delta]}\right]^{\frac{\alpha}{1-\alpha-\delta}}$

Subsidy/tax rates: $\sigma_{ss}^{FB} = \frac{\beta nRwa+\beta n\delta}{1+\beta nRwa}; \tau_{ss}^{y,FB} = \sigma_{ss} e_{ss}$ and $\tau_{ss}^{a,FB} = 0$

II. Theory - The second best utilitarian solution

Levying taxes induces some fiscal distortions: $c(\tau_t^y)$
Second best problem at time 0:

$$
\begin{aligned}
\ell^{SB} = & \frac{A_0 c_0}{\beta} \\
& + \sum_{t=0}^{\infty} \beta^t \{ A_{t+1} \left[Rwah_t - R(1-\sigma_t)e_t - R\tau_t^y + wh_{t+1} - \tau_{t+1}^a \right] \\
& + \lambda_t A_{t+1} \left[e_t^\alpha h_t^\delta - h_{t+1} \right] \\
& + \rho_t A_{t+1} \left[\tau_t^y - c(\tau_t^y) - \sigma_t e_t \right] \\
& + \mu_t A_{t+1} \left[\alpha h_t^\delta \left[w + m_{t+1}(w^* - w) \right] - R(1-\sigma_t) e_t^{1-\alpha} \right] \}
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial \ell^{SB}}{\partial h_{t+1}} &= \beta^t A_{t+1} w + \beta^{t+1} A_{t+2} Rwa - \beta^t A_{t+1} \lambda_t \\
&+ \beta^{t+1} A_{t+2} \lambda_{t+1} e_{t+1}^{\alpha} \delta h_{t+1}^{\delta-1} \\
&+ \beta^{t+1} A_{t+2} \mu_{t+1} \alpha \left[w + m_{t+2}(w^* - w) \right] \delta h_{t+1}^{\delta-1} \\
\frac{\partial \ell^{SB}}{\partial e_t} &= -\beta^t A_{t+1} R(1-\sigma_t) + \beta^t A_{t+1} \lambda_t \alpha e_t^{\alpha-1} h_t^{\delta} - \beta^t A_{t+1} \rho_t n \sigma_t \\
&- \beta^t A_{t+1} R(1-\sigma_t) \mu_t (1-\alpha) e_t^{-\alpha} \\
\frac{\partial \ell^{SB}}{\partial \sigma_t} &= \beta^t A_{t+1} R e_t - \beta^t A_{t+1} \rho_t n e_t + \beta^t A_{t+1} \mu_t R e_t^{1-\alpha} \\
\frac{\partial \ell^{SB}}{\partial \tau_t^y} &= -\beta^t A_{t+1} R + \beta^t A_{t+1} \rho_t n \left[1 - c^{'}(\tau_t^y) \right] \\
\frac{\partial \ell^{SB}}{\partial m_{t+1}} &= -\beta^t A_t n C_{t+1} + \beta^t A_{t+1} R \mu_t \alpha h_t^{\delta} (w^* - w)
\end{aligned}
$$

At the steady state

$$
\begin{array}{rrcl}
(i) & 0 & = & w\left[1+\beta n(1-m)Rwa\right]-\lambda\left[1-\beta n(1-m)\delta\right] \\
 & & & +\beta n(1-m)\mu\alpha\left[w+m(w^{*}-w)\right]\delta h^{\delta-1} \\
(ii) & 0 & = & -R(1-\sigma_t)+\lambda\alpha e^{\alpha-1}h^{\delta}-\rho n\sigma-\mu R(1-\sigma)(1-\alpha)e^{-\alpha} \\
(iii) & 0 & = & R-\rho n+\mu Re \\
(iv) & 0 & = & -R+\rho n\left[1-c^{'}(\tau^{y})\right] \\
(v) & 0 & \geq & -C+\mu(1-m)R\alpha h^{\delta}(w^{*}-w)
\end{array}
$$

When $c^{'}(\tau^{y})=0$, $\rho n=R$; $\mu=0$: the optimal migration rate is zero; $\lambda{=}\lambda_{ss}^{FB}$
When $c^{'}(\tau^{y})>0$, $\rho n>R$, $\mu>0$: so that the optimal migration can be positive.

II. Theory - The second best utilitarian solution

For simplicity, let us consider linear perception costs: $c^{'}(\tau^{y}) = \gamma$ (administrative costs, bad governance, kleptocrats)

We have

$$\lambda_{ss}^{SB} = \frac{w\left\{1+\beta n(1-m)Rwa+\beta n(1-m)\frac{\gamma\delta\alpha}{1-\gamma}\left[1+m\frac{(w^{*}-w)}{w}\right]\right\}}{1-\beta n(1-m)\delta}$$

$$e_{ss}^{SB} = \left[\frac{\alpha h^{\delta}\left[(1-\gamma)\lambda+\alpha\gamma\left(w+m(w^{*}-w)\right)\right]}{R}\right]^{\frac{1}{1-\alpha}}$$

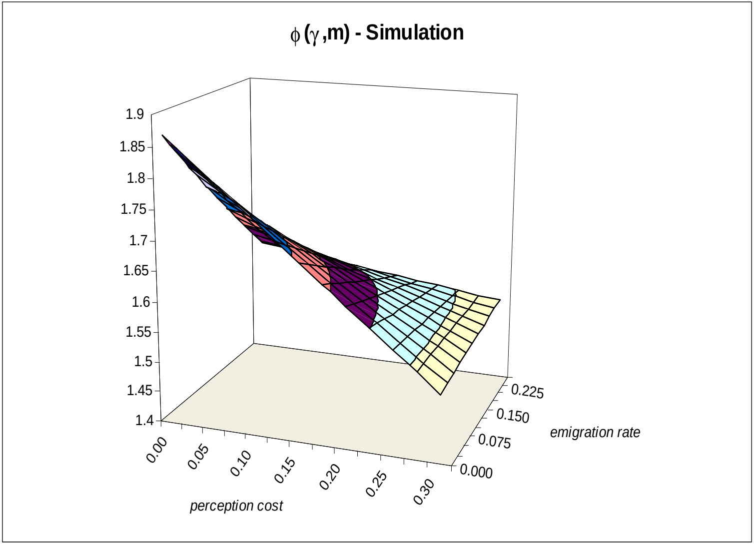
$$h_{ss}^{SB} = \left[\frac{\alpha w\phi(\gamma,m)}{R}\right]^{\frac{\alpha}{1-\alpha-\delta}}$$

with

$$\phi \equiv \frac{(1-\gamma)[1+\beta n(1-m)Rwa]+\gamma\beta n(1-m)\alpha\delta\left[1+m\frac{(w^{*}-w)}{w}\right]+\alpha\gamma\left[1+m\frac{(w^{*}-w)}{w}\right][1-\beta n(1-m)\delta]}{1-\beta n(1-m)\delta}$$

II. Theory - The second best utilitarian solution

ϕ is decreasing in γ and m : $\left(w\phi(0,0) = \frac{w[1+\beta nRwa]}{1-\beta n\delta} = \lambda_{ss}^{FB}\right)$



II. Theory - The second best utilitarian solution

Decentralizing the second best

$$\sigma_{ss}^{SB} = \frac{\phi(\gamma, m) - 1 - m\frac{(w^* - w)}{w}}{\phi(\gamma, m)}$$

$$\frac{\partial \sigma}{\partial m} = \frac{(1 + m\frac{(w^* - w)}{w})\phi_m^{'} - \frac{(w^* - w)}{w}\phi}{\phi^2} < 0$$

$$\frac{\partial \sigma}{\partial \gamma} = \frac{(1 + m\frac{(w^* - w)}{w})\phi_\gamma^{'}}{\phi^2} < 0$$

σ_{ss}^{SB} falls to zero when γ sufficently high (when $\phi(\gamma, m) < 1 + m\frac{(w^* - w)}{w}$)

II. Theory - The second best utilitarian solution

Conditions (i) to (iv) characterize the second best solution with exogenous migration rates (i.e. when individuals are free to leave their country and emigration rates are determined by immigration restrictions in receiving countries):

Proposition 2: In the case of exogenous emigration rates and linear perception costs, the optimal level of human capital and the subsidy rate decrease in m

II. Theory - The second best utilitarian solution

Interpretation:

- the probability of migration reduces the social return to education (less remaining adults means less externalities)
- migration stimulates the laissez-faire investment in education

$\Longrightarrow$ The optimal subsidy rate falls.

II. Theory - The second best utilitarian solution

Is migration welfare-improving?

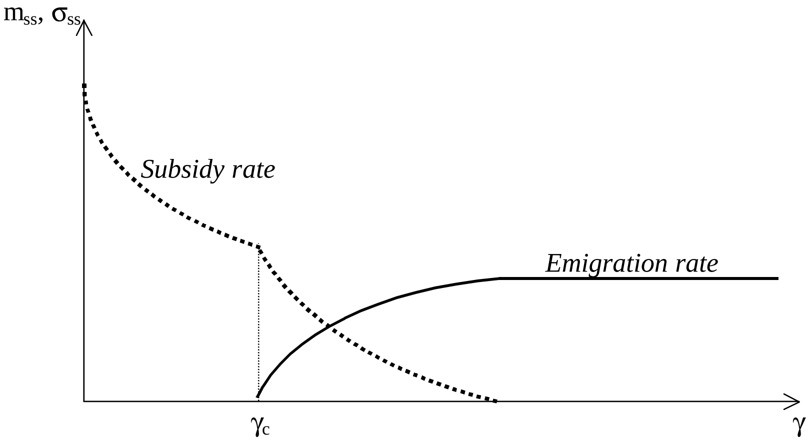
Proposition 3: Under linear perception costs, there is a cutoff level of distortion γ_c under which the optimal migration rate is zero and above which the optimal migration rate is positive.

Condition for a positive emigration rate is $\frac{\partial \ell^{SB}}{\partial m} > 0$ evaluated at $m = 0$. This implies

$$\frac{\gamma}{1-\gamma}\alpha h^{\delta}(w^{*} - w) > wh(1 + aR) - e$$

RHS decreases in γ (increasing γ reduces the level of education)
LHS increases in γ (tends to infinity when γ tends to one)

Fig 1. Perception costs, optimal subsidy and emigration rates



BD always detrimental at FB; can be beneficial at the SB if γ is high

III. The empirical relationship between migration and subsidies

- **Model and data**
- **Empirical results**
- **Simulations**

III Empirics - What to be tested?

Prediction: negative relationship between skilled emigration rates and public education subsidies.
Two empirical issues:

- Do human capital accumulation and public subsidies respond to skilled migration rates?
- Does the endogeneity of public subsidies modify the gains and losses?

III Empirics - Data on skilled migration

- Main difficulty: to collect migration data by educational attainment
- New data set on international migration by educational attainment (DM05)
- Describes the loss of skilled workers to the OECD for all countries in 1990 and 2000

- Emigration stocks (aggregating immigration data collected in all OECD countries). Count as migrants all working-aged (25 and over) foreign born individuals living in an OECD country. Three levels of schooling are distinguished
- These numbers are expressed in percentage of the total labor force born in the sending country = dividing the emigration stocks by the total number of people born in the source country and belonging to the same educational category
- Corrected rates by age of entry - BDR07
- Our sample: we eliminate high-income countries + countries for which data on public expenditures in education are not available +countries in civil war (max 108 countries).

Two variables:

- The formation of human capital is measured as the change in the proportion of high-skill natives between 1990 and 2000
- Education subsidies are measured as the public expenditures in tertiary education per student, in percentage of the GDP per capita.

III Empirics - Model

Two equations:
HC: β-convergence equation

$$\ln\left(\frac{H_{00}}{H_{90}}\right) = h\left[\ln(m_{90}), \ln(H_{90}), \ln(\sigma_{90}), I_{90}, UR_{90}, R_{90}, PopS_{90}, REG\right]$$

Education subsidies:

$$\ln(\sigma_{90}) = \sigma\left[\ln(m_{90}), R_{90}, I_{90}, UR_{90}, GE, REG, POV\right]$$

- Potential endogeneity of the high-skill emigration rate, m_{90}. We compare OLS and IV (excluded intruments: distance OECD, landlocked dummy, small island dummy)
- Relevance of instruments: first stage F stat, Anderson canonical LR,Cragg-Donald
- Validity (exogeneity) of instruments: Hansen J stat
- Endogeneity of $ln(m_{90})$: C-test (equivalent to Hausman test)
- Check for collinearity; correction for heteroskedasticity
- Not reported: 3SLS + alternative specifications (identical results)

	OLS 1	OLS 2	IV 1	IV 2
$\ln(m_{90})$	0.042**	0.032**	0.082**	0.077**
	(0.021)	(0.006)	(0.036)	(0.037)
$\ln(H_{90})$	-0.285***	-0.273***	-0.278***	-0.278***
	(0.039)	(0.038)	(0.040)	(0.040)
$\ln(\sigma_{90})$	0.119**	0.121**	0.125**	0.116**
	(0.058)	(0.049)	(0.060)	(0.053)
$S15/24$	-2.227***	-2.346***	-1.897**	-1.907**
	(0.860)	(0.792)	(0.821)	(0.807)
$S49/55$	-10.44***	-10.11***	-10.57***	-10.37***
	(3.215)	(2.972)	(3.112)	(3.086)
UR_{90}	0.228*	0.263**	0.410***	0.380***
	(0.137)	(0.117)	(0.148)	(0.147)
R_{90}	-0.000*		-0.000*	
	(0.000)		(0.000)	
I_{90}	-0.000		-0.000	
	(0.000)		(0.000)	

	OLS 1	OLS 2	IV 1	IV 2
F-statistic	32.255	41.265	36.438	40.021
N. Obs	88	105	104	105
Hansen test (i)			4.622	3.567
p-value			0.099	0.168
First-stage F stat.(ii)			13.69	14.65
Anderson test (iii)			38.398	38.793
p-value			0.000	0.000
Cragg-Donald test (iv)			13.398	13.707
C-test (v)			1.763	1.319
p-value			0.184	0.251

III Empirics - Table 2: idem controlling for age of entry

	J = 12		J = 18		J = 22	
	OLS	IV	OLS	IV	OLS	IV
$\ln(m_{J,90})$	0.032**	0.077**	0.033**	0.077**	0.033**	0.077*
	(0.015)	(0.036)	(0.016)	(0.036)	(0.016)	(0.036
$\ln(H_{J,90})$	-0.273***	-0.279***	-0.273***	-0.277***	-0.273***	-0.277*
	(0.038)	(0.040)	(0.038)	(0.040)	(0.038)	(0.040
$\ln(\sigma_{90})$	0.121**	0.116**	0.121**	0.116**	0.120**	0.115*
	(0.049)	(0.053)	(0.048)	(0.051)	(0.048)	(0.051
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
F-statistic	41.45	40.11	41.29	40.28	41.37	40.24
N. Obs	104	104	104	104	104	104

III Empirics - Table 3: Education subsidy rate

	OLS 1	IV 1	OLS 2	IV 2
$\ln(m_{90})$	-0.039*	-0.232***	-0.051*	-0.201***
	(0.041)	(0.075)	(0.032)	(0.057)
l_{90}	0.000**	0.000**	0.000**	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
$RLAW$	0.494***	0.407***	0.420***	0.363***
	(0.117)	(0.138)	(0.109)	(0.124)
$MINC$	0.503***	0.333**	0.512***	0.391***
	(0.136)	(0.148)	(0.130)	(0.125)
R_{90}	-0.000	-0.000		
	(0.000)	(0.000)		
$REGD$	Yes	Yes	Yes	Yes

III Empirics - Table 3: Education subsidy rate

	OLS 1	IV 1	OLS 2	IV 2
F-statistic	80.80	52.34	101.63	72.51
N. obs	92	92	107	107
Hansen test (i)		1.827		1.410
p-value		0.176		0.235
First-stage F stat.(ii)		11.18		11.94
Anderson test (iii)		26.65		32.32
p-value		0.000		0.000
Cragg-Donald test (iv)		13.44		16.93
C-test (v)		7.86		7.856
p-value		0.005		0.005

III Empirics - Simulations as in BDR

Use model to simulate the impact of a change in skilled migration on human capital between 1990 and 2000. Counterfactual experiment: equating the skilled emigration rate to the unskilled rate: $m_{90} \longrightarrow m_{90}^{u}$

- Compute the effect on subsidies

$$\ln(\widehat{\sigma}_{90}) = \sigma\left[\ln(m_{90}^{u}), R_{90}, I_{90}, UR_{90}, GE, REG, POV\right]$$

- Compute the stock of human capital of natives:

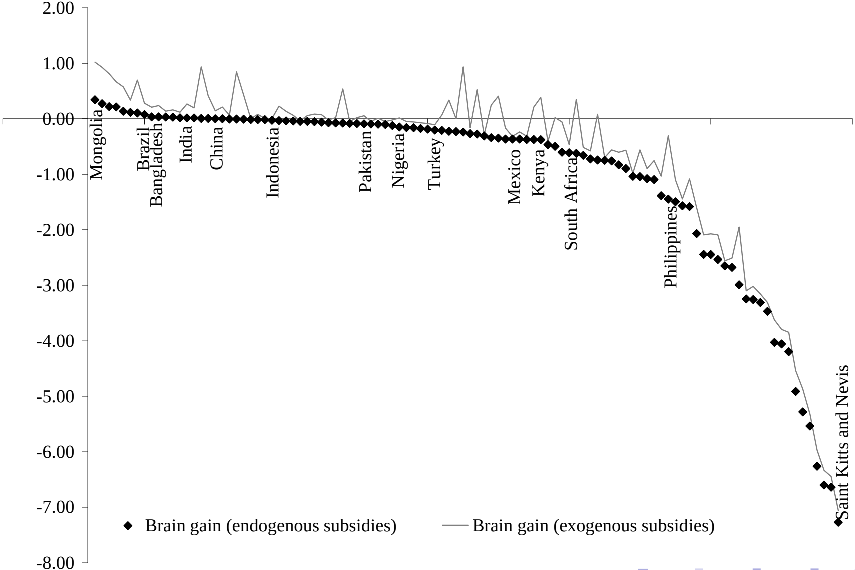
$$\ln \widehat{H}_{00} = \ln H_{90} + h\left[\ln(m_{90}^{u}), \ln(H_{90}), \ln(\widehat{\sigma}_{90}), UR_{90}, PopS_{90}, REG\right]$$

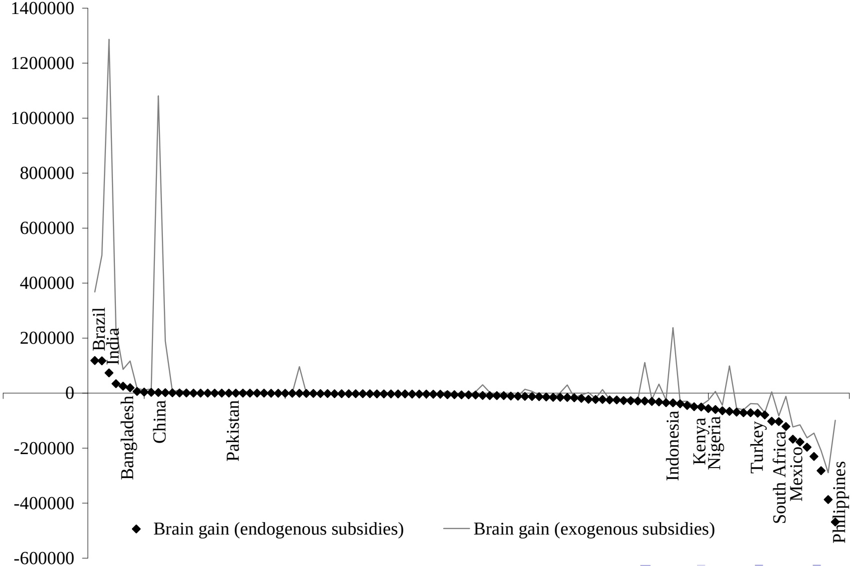
- Compute the stock of human capital of residents
- NB: BDR use the same method but consider σ_{90} as given

III Empirics - Simulations as in BDR

- 108 DBD cases / 20 BDB cases
- BBD gains are small
- DBD losses are large for many countries ($>$1 point for 30 countries)
- BD induces a global loss for developing world (-2.7%)
- With exogenous subsidies (BDR), 51 BBD cases and global gain for developing world (+2.6%)

III Empirics - Net effect on proportion of educated




1400000
1200000
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-600000
Brazil
India
Bangladesh
China
Pakistan
Indonesia
Kenya
Nigeria
Turkey
South Africa
Mexico
Philippines
Brain gain (endogenous subsidies)
Brain gain (exogenous subsidies)

IV. Conclusion

- Theoretical findings
- Empirical findings
- Counterfactual experiments

IV. Conclusion - Theoretical findings (if BBD)

- If the government is concerned by the number of skilled residents, the optimal migration rate is zero at the first best (at low efficiency cost, "brain gain" hardly resists a normative welfare analysis)
- Skilled emigration = second best policy option reflecting the inability of the governement to use domestic instruments at low efficiency cost

IV. Conclusion - Empirical findings

- Confirm incentive mechanism (+3.2 or 4.2%) + important role of education subsidies (+12%)
- Significant and negative relationship between skilled migration and subsidies (-20%)

IV. Conclusion - Counterfactual experiment

- The endogeneity of public subsidies reduces the relative number of BBD (from 51 to 20 countries out of 108), increases the social cost of the BD for the losers
- Global loss for developing world (-2.7% of post-secondary)
- Although skilled migration is likely to affect other sectors of the economy, the perspectives of beneficial brain drain appear more limited than in previous studies