Capital Flows between Rich and Poor Countries

Francesco Caselli

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Lucas (1990)

- Big differences in y.
- Suppose they are due to differences in k (physical only).
- Then MPK differences must be huge
  - e.g. with Cobb-Douglas:

$$y = k^{\beta}$$

$$MPK = \beta k^{\beta-1} = \beta y^{\frac{\beta-1}{\beta}}.$$

With $\beta = 0.4$ implies factor of 58 between India and US. How can this be?

Explanation L1: Human Capital

Suppose

$$y = k^{\beta} h^{1-\beta}$$

$$MPK = \beta k^{\beta-1} h^{1-\beta} = \beta y^{\frac{\beta-1}{\beta}} h^{\frac{1-\beta}{\beta}}.$$

With $\beta = 0.4$ and using estimates of h (from Krueger, 1968) brings India-US difference down to 5. Still big. (See also Mankiw, BPEC).

Explanation L2: Differences in A

- Suppose

$$y = Ak^{\beta}h^{1-\beta}$$

$$MPK = \beta A k^{\beta-1}h^{1-\beta}$$

- Big differences in k consistent with MPK-equalized if A higher in rich countries (Lucas had in mind human-capital externalities, but of course many other possibilities).

- Certainly a very plausible contender. Development Accounting (Hall and Jones, QJE; Klenow and Rodriguez-Clare, Macro Annual; Caselli, Handbook of Ec. Growth):

$$y = Ak^{\beta}h^{1-\beta}.$$

  with $\beta = 0.33$, and measured k and h (see below) variation in A explains more than 50% of variation in y.

Explanation S (Samuelson): specialization

- Multi-sector models with trade offer another explanation: as they accumulate capital countries jump to more capital-intensive goods.

- In a way it is as if higher k countries had higher β, or as if the EOS between k and l was infinite.

- Factor prices are equalized: again differences in k consistent with equalized MPK.

Checking Explanations L2 and S: are MPKs equalized? (Caselli and Feyrer)

- Some approaches to estimating MPKs
  - Comparisons of interest rates
  - Regressions of ΔY on ΔK
  - Calibration. E.g. Lucas' calculation

Approach of this paper

Constant returns and competitive markets

$$\text{Capital Income in country } i = MPK^i \times K^i$$

Then

$$MPK^i = \frac{\alpha^i Y^i}{K^i}$$

where α^i is measured capital share in income (country specific!)

No functional form assumptions

No need to estimate complementary factors, such as h

Data

α^i from Bernanke and Gurkaynak (2001)

K and Y from PWT

One cross-section

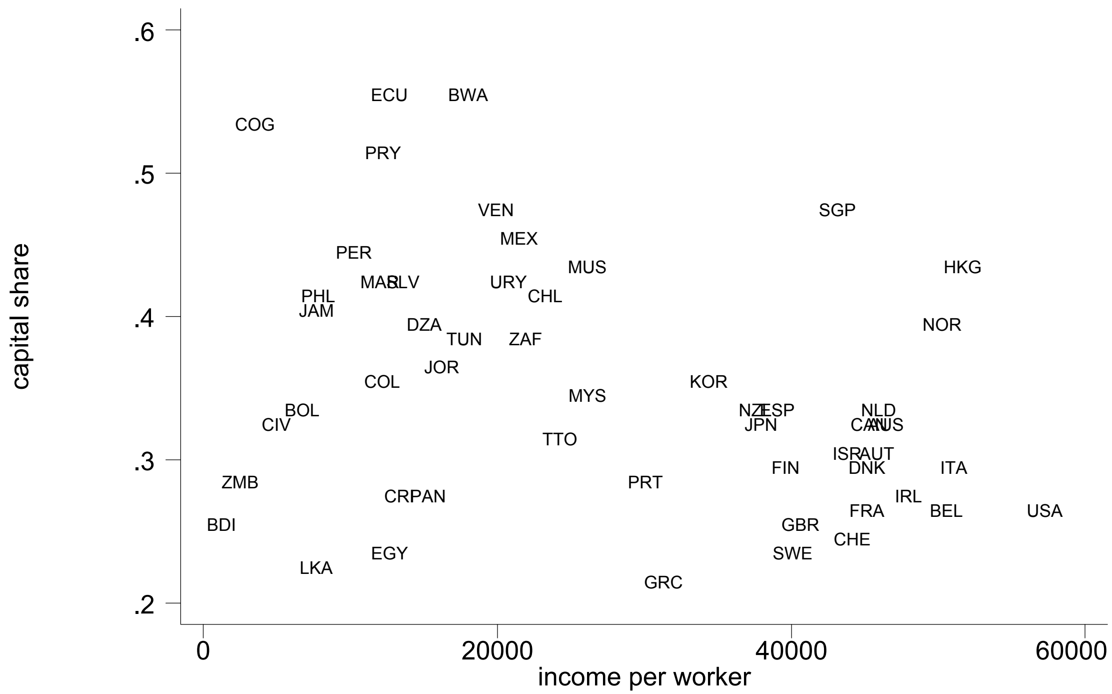


Figure 1: Capital Shares

What we get

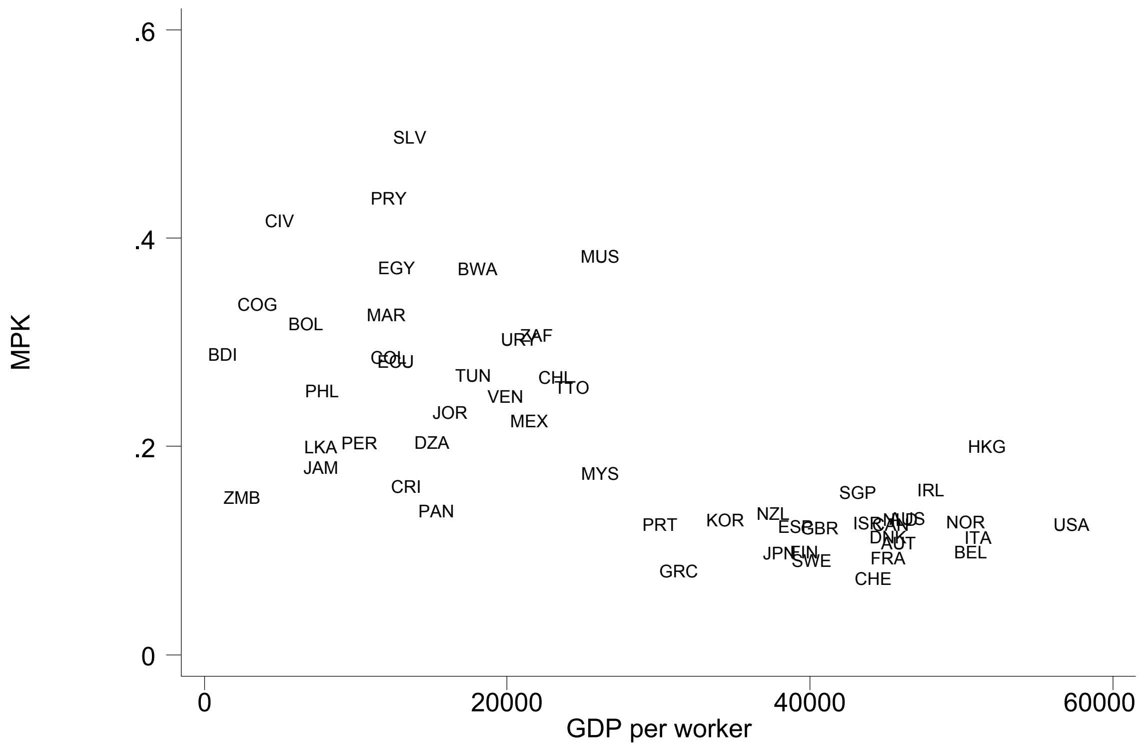


Figure 2: Implied MPKs

Poor-rich ratio approx. 2.5

Deadweight loss calculation

Counterfactual world GDP if existing K redistributed to equalize MPKs

(Abstract from changes in aggregate K).

Now need a functional form assumption:

$$y^i = (k^i)^{\alpha^i}(X^i)^{1-\alpha^i},$$

where $(X^i)^{1-\alpha^i}$ is a summary of the complementary factors (e.g. Ah). MPK is

$$MPK^i = \alpha^i(k^i)^{\alpha^i-1}X^{1-\alpha^i}.$$

Constant-MPK counter-factual k in country i

$$(k^i)^* = \left(\frac{\alpha^i}{MPK^*}\right)^{\frac{1}{1-\alpha^i}} X^i.$$

Resource constraint

$$\sum(k^i)^*L^i = \sum k^iL^i,$$

Substitute $(k^i)^*$ and solve for MPK^*

$$\sum\left(\frac{\alpha^i}{MPK^*}\right)^{\frac{1}{1-\alpha^i}} X^iL^i = \sum k^iL^i$$

Counter-factual distribution of k

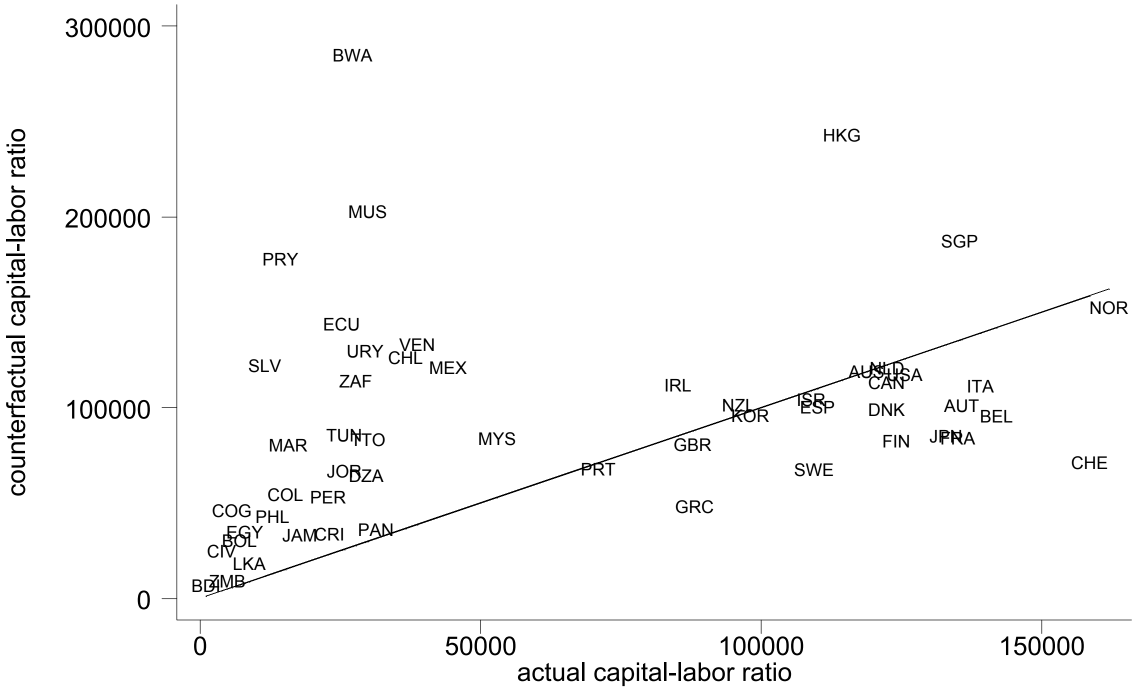


Figure 3: Effects of MPK Equalization on Capital

Average poor-country increase: unweighted 300%; weighted 235%
Average rich-country decrease: unweighted 12%; weighted 18%
Amount of reallocated capital: 18% of world stock

Counterfactual distribution of y

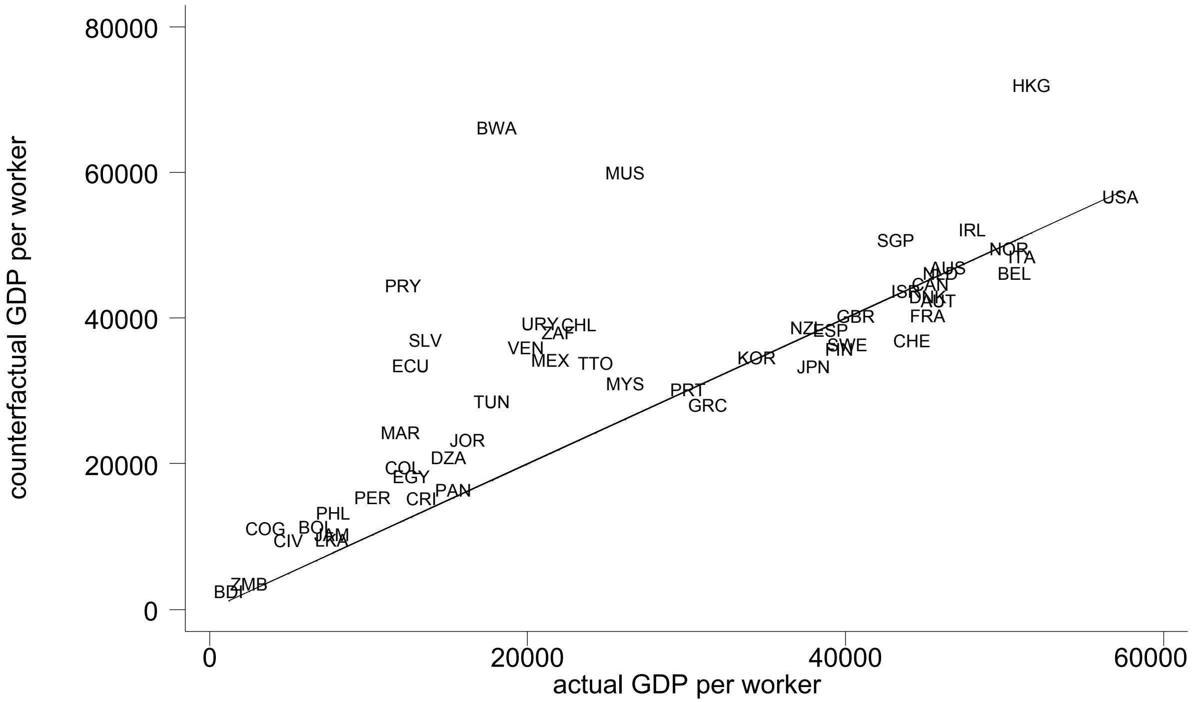


Figure 4: Effects of MPK Equalization on Output

Average poor-country increase: unweighted 75%; weighted 58%
Average rich-country decrease: unweighted 3%; weighted 8%
“World” gains 3% percent (or 25% of combined GDP of the “poor”)

Explanation L3: International Credit Frictions

- N does not lend much because S cannot credibly commit to repay

- MPKs differences reflect a "default risk premium"

- Lots of evidence that capital flows to countries with better "institutions" (See Reinhart and Rogoff)

Checking Explanation L3: are financial rates of return higher in poor countries?

Consider equipment-investment decision when funds can be borrowed or lent at rate R^i

$$\frac{P_y^i(t)MPK^i(t) + P_k^i(t+1)(1-\delta)}{P_k^i(t)} = R^i$$

Abstracting from capital gains

$$\frac{P_y^i MPK^i}{P_k^i} = R^i - (1-\delta)$$

No credit frictions if $R^i = R^*$, or

$$\frac{P_y^i MPK^i}{P_k^i} = R^* - (1-\delta)$$

So we do not expect MPK equalization!

A more precise restatement

Each country produces an homogeneous tradable consumption good and a non-tradable consumption good. Each country imports capital from the "US"

(possibly with a tariff)

Capital Share

$$\begin{aligned}\alpha^i &= \frac{P_T MPK_T^i K_T^i + P_{NT}^i MPK_{NT}^i K_{NT}^i}{Y_D^i} \\ &= \frac{P_T MPK_T^i \left(K_T^i + K_{NT}^i\right)}{Y_D^i} = \frac{P_T MPK_T^i K^i}{Y_D^i},\end{aligned}$$

where

$$Y_D^i \equiv P_T Y_T^i + P_{NT}^i Y_{NT}^i,$$

is GDP at domestic prices.

Hence, the object we call MPK is

$$MPK = \frac{\alpha^i Y^i}{K^i} = \frac{P_T MPK_T^i Y^i}{Y_D^i} = \frac{P_T MPK_T^i}{P_y^i},$$

No credit frictions if

$$\frac{P_T MPK_T^i}{P_k^i} = R^* - (1 - \delta),$$

Or

$$\frac{P_y^i MPK^i}{P_k^i} = R^* - (1 - \delta)$$

Reinterpretation of MPK:

$$MPK = \frac{MPK_T MPK_{NT}}{\gamma MPK_{NT} + (1-\gamma) MPK_T}.$$

(Also need to assume same shares in tradables and nontradables for dead-weight loss calculations)

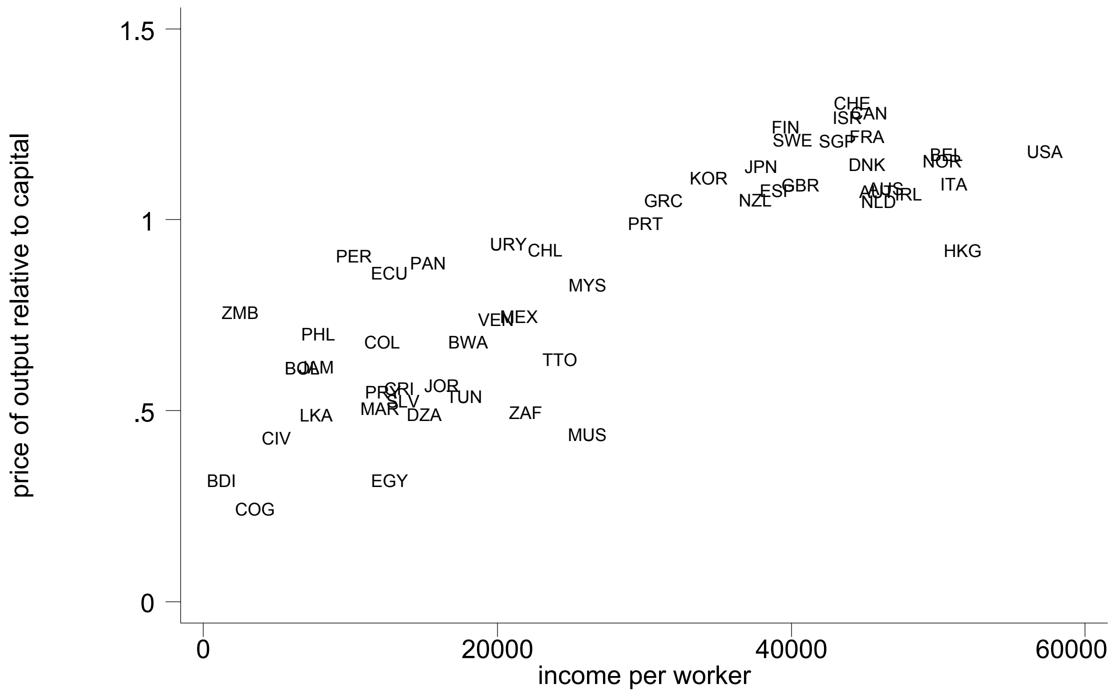


Figure 5: Plot of $\frac{P_y}{P_k}$

Theories of P_y/P_k

Taxes on capital purchases (e.g. Chari et al.).

Relative productivity of investment sector (e.g. Hsieh and Klenow).

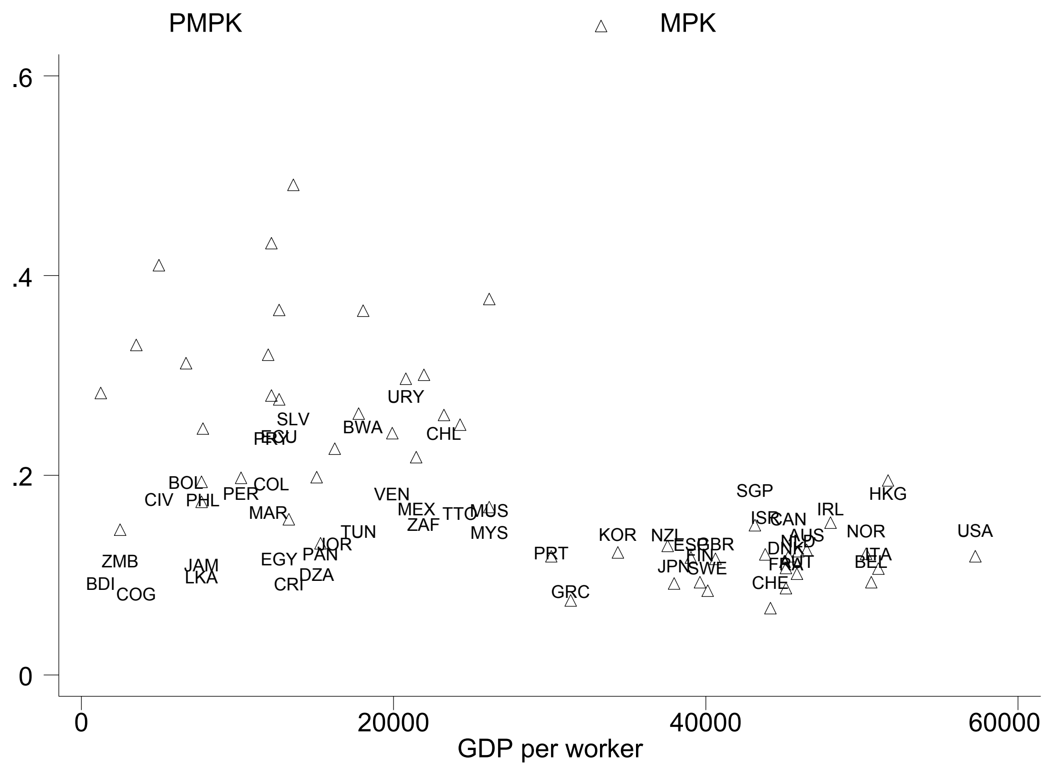


Figure 6: Plot of $\frac{P_y MPK}{P_k}$ and MPK

Low income mean 0.16 (vs. 0.28 for MPK), high income mean 0.13 (vs. 0.12). Also much less variance.

Deadweight loss of credit frictions

Existing K redistributed to equalize $P_y \text{MPK}/P_k$

Interpretation: component of deadweight loss from MPK differentials that is attributable to credit frictions (remainder is attributable to P_y/P_k).

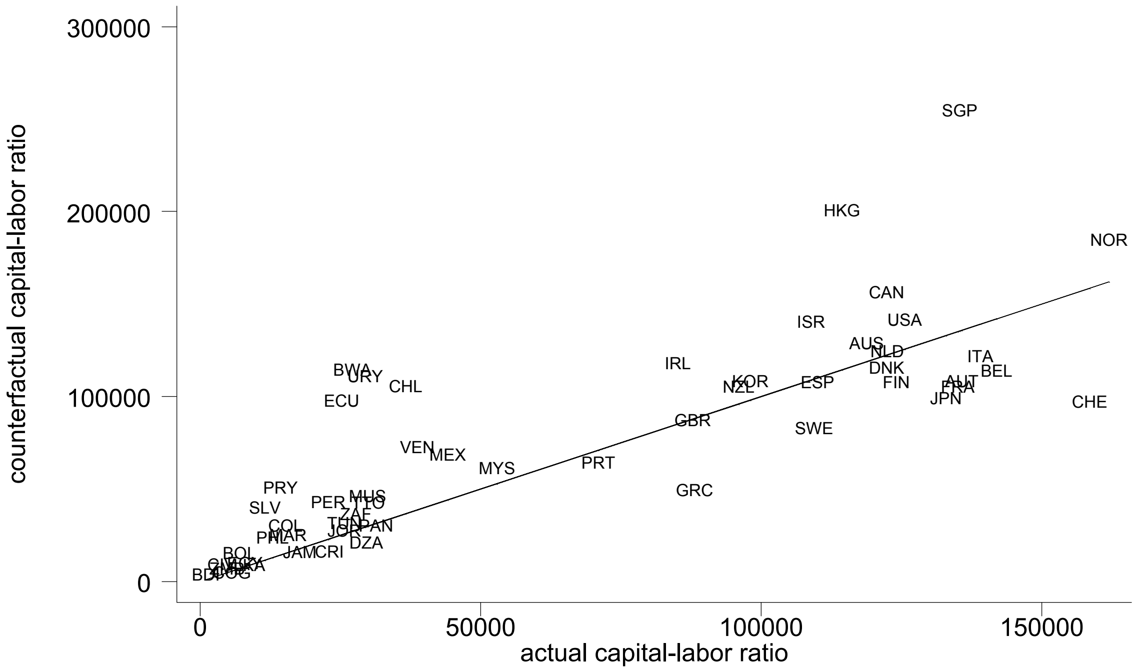


Figure 7: Effects of PMPK Equalization on Capital

Average poor-country increase: unweighted 61%; weighted 46%
Average rich-country decrease: unweighted 0%; weighted 4%
Amount of reallocated capital: 10% of world stock

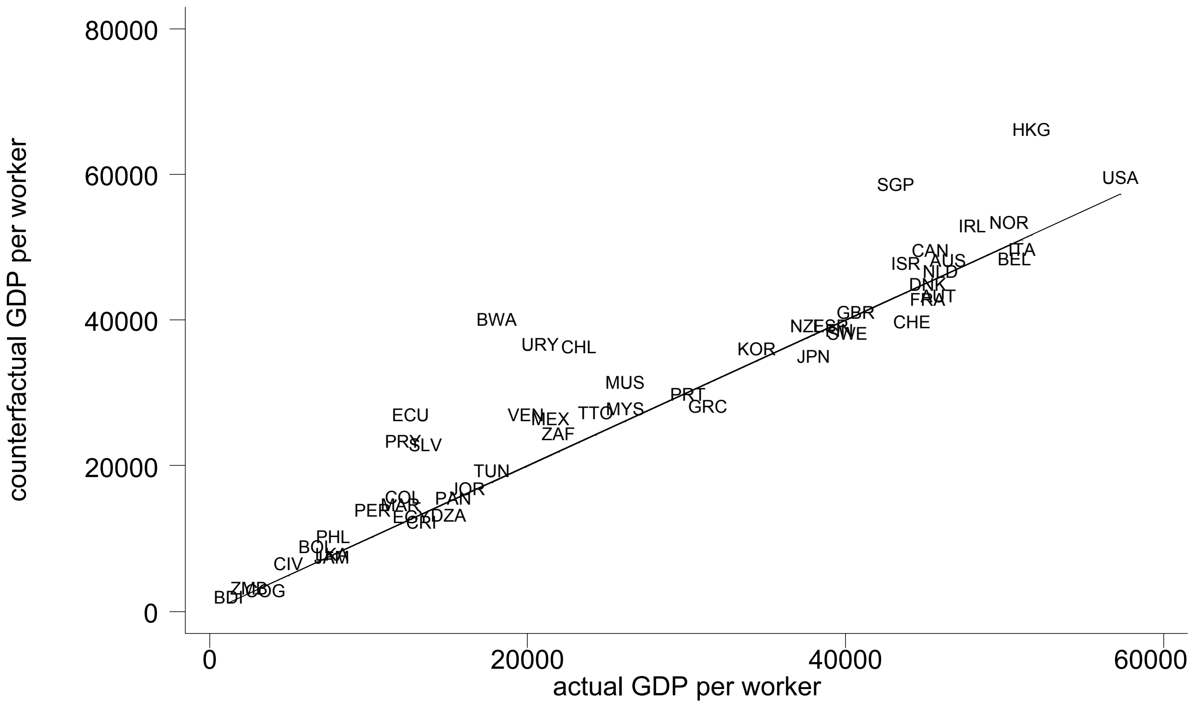


Figure 8: Effects of PMPK Equalization on Output

Average poor-country increase: unweighted 20%; weighted 16%
Average rich-country decrease: unweighted 0%; weighted 1%
"World" gains 1% percent

Revisiting the Lucas question

$$\frac{\text{weighted average rich-country } k}{\text{weighted average poor-country } k} = 5.27$$

Component explained by X

$$\frac{\text{weighted average rich-country } k^*}{\text{weighted average poor-country } k^*} = 1.4$$

where k^* is the counterfactual with constant MPK

Component explained by X and P_y/P_k

$$\frac{\text{weighted average rich-country } k^*}{\text{weighted average poor-country } k^*} = 3.3$$

where k^* is the counterfactual with constant $P_y MPK/P_k$

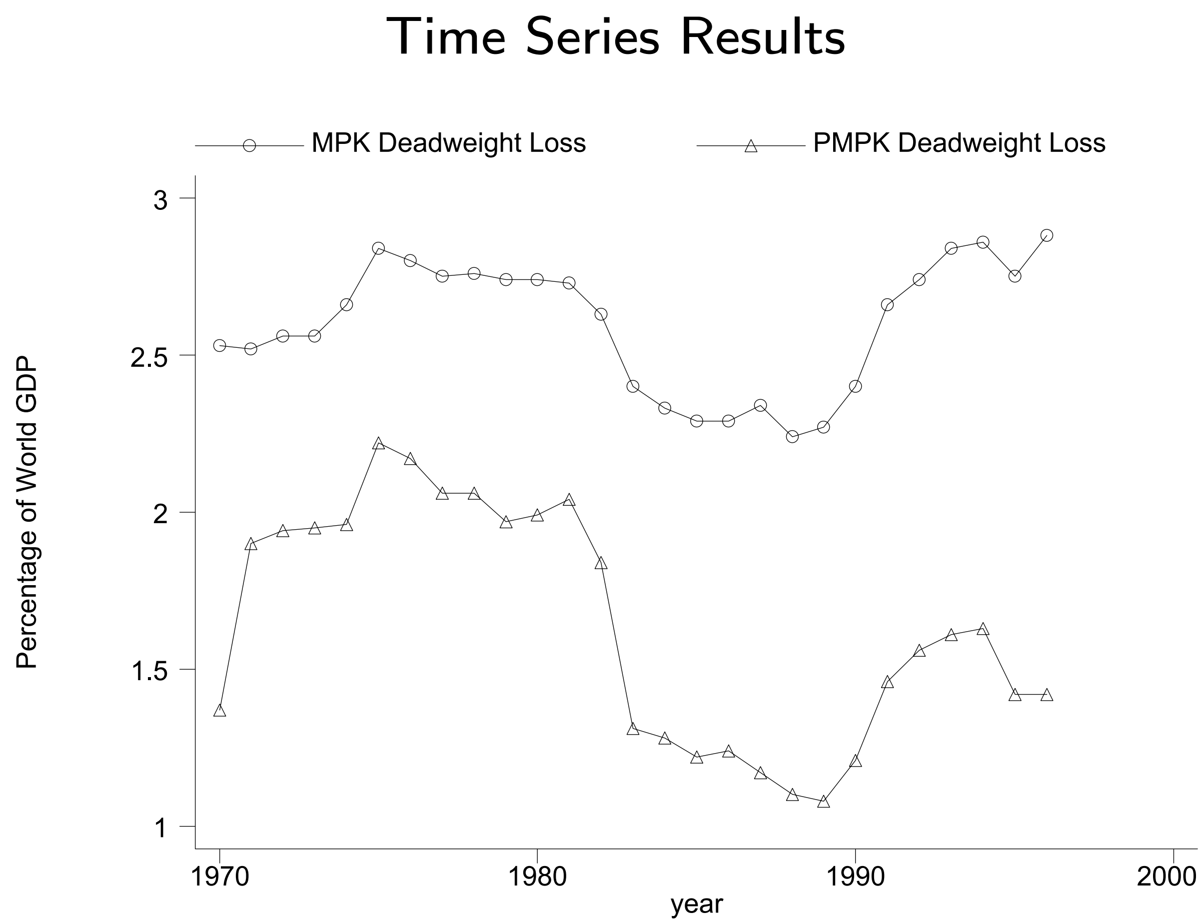


Figure 9: The Cost of MPK and PMPK Differentials

Conclusions

There are significant and costly MPK differentials

But credit market imperfections account for only 1/3 of the deadweight loss from unequal MPKs

Differences in P_y/P_k account for 2/3

Implication for aid policy

Large poor-rich "physical" MPK differentials usually seen as good reason to increase aid flows

But with small poor-rich "financial" MPK differentials increased aid flows likely to be offset by increased private flows in opposite direction

Caveat: A model with credit frictions, financial rate of return equalization, and differences in MPKs (Matsuyama, JEEA 2005)*

- Unique consumption good, CRS technology, $F(K, L)$, $f'(0) = \infty$.

- Competitive factor markets. L inelastic.

- Production of physical capital. 1 unit of c-good and 1 entrepreneur produce R units of K. Each entrepreneur can produce only R units of K.

- Mass 1 continuum of potential entrepreneurs. Each entrepreneur endowed with $\omega < 1$ units of c-good. (Hence must borrow $1 - \omega$).

- Credit-market imperfection: entrepreneur can pledge up to a fraction $\lambda \leq 1$ of the return from project [i.e. $\lambda R f'(k)$].

*See also Gertler and Rogoff (JME 1990) who get similar results.

Key Equilibrium Conditions

- Entrepreneur must decide whether to borrow or lend. Participation constraint (PC)

$$Rf'(k) \geq r,$$

where r is the borrowing/lending rate.

- Entrepreneur must credibly promise to repay. Incentive compatibility constraint (IC)

$$\lambda Rf'(k) \geq r(1 - \omega)$$

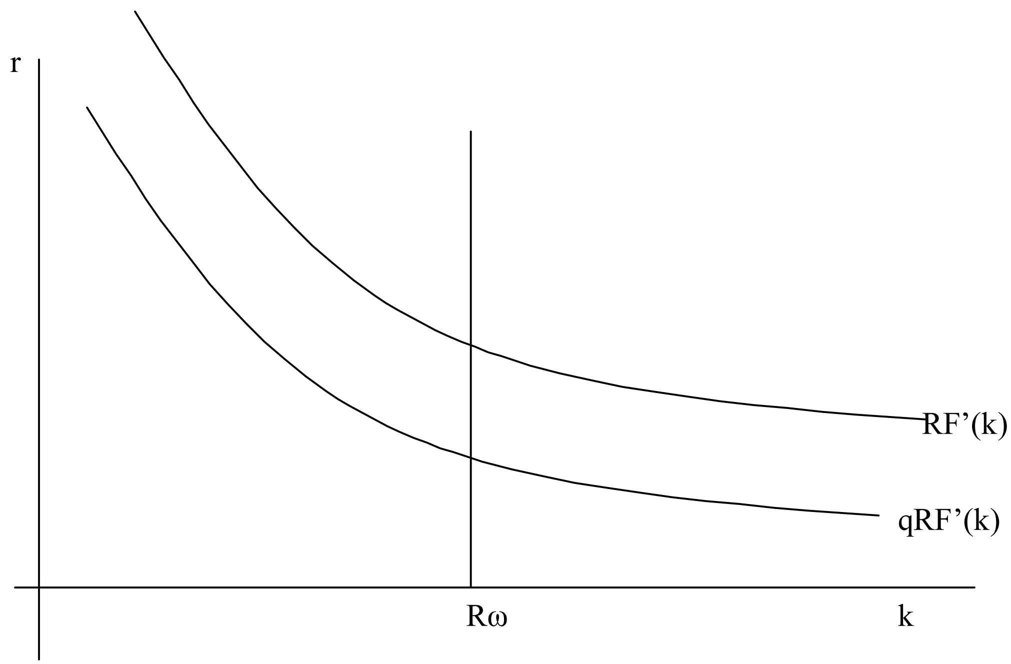
Closed-economy Equilibrium

- Since $f'(0) = \infty$ some people must be borrowers in equilibrium.

- Since someone must lend one of the two constraints must bind:
$$r = \min\left\{1, \frac{\lambda}{1-\omega}\right\} Rf'(k)$$
(The IC constraint binds when λ and ω are small - i.e. when need to borrow a lot and can promise little)

- Total c-good available for investment in projects: $\omega \times 1 = \omega \rightarrow$ At most $\omega < 1$ people will be entrepreneurs, and the supply of capital is at most $R\omega$.

- Equilibrium number of entrepreneurs is indeed ω. Suppose it is less. Then some people are neither borrowing nor lending (return on their wealth is 0). They will offer to lend at lower r. See figure for case $q = \lambda/(1-\omega) < 1$. (But same is true regardless).



- In a closed economy always $k = R\omega$.

- MPK is lower in rich economy.

Open-economy Equilibrium

- Assume $\lambda_N > \lambda_S$, $\omega_N > \omega_s$. Immobile L, k, and entrepreneurs. C-good is mobile.

- Since $f'(0) = \infty$ there are some entrepreneurs in both S and N.

- Focus on equilibria with lenders in both N and S,and hence $r_s = r_N$, and

$$\min\left\{1, \frac{\lambda_N}{1-\omega_N}\right\} Rf'(k_N) = \min\left\{1, \frac{\lambda_S}{1-\omega_S}\right\} Rf'(k_S)$$

(Interest rates are equalized!)

- Resource constraint

$$k_N + k_S = R(\omega_N + \omega_S)$$

- Two equations in two unknowns pin down equilibrium.

Case 1: $\lambda_S/(1-\omega) > 1$ (Good credit markets)

- $\frac{\lambda_S}{1-\omega_S} > 1$ implies $\frac{\lambda_N}{1-\omega_N} > 1$ and hence

$$k_N = k_S.$$

- MPKs equalized

- Capital flows from N to S

Case 2: $\lambda_S/(1-\omega) < 1$ (Bad credit markets)

- $\frac{\lambda_S}{1-\omega_S} < 1$ implies $\min\left\{1, \frac{\lambda_N}{1-\omega_N}\right\} > \min\left\{1, \frac{\lambda_S}{1-\omega_S}\right\}$ and hence
$$k_N > k_S$$

- MPK higher in S

- Capital may flow either from N to S or from S to N. (In latter case MPK differences are bigger than in autarky).†

- Note that reverse flows may occur even if $\lambda_S = \lambda_N$

†Capital flows from S to N if

$$\min\left\{1, \frac{\lambda_N}{1-\omega_N}\right\} Rf'(R\omega_N) > \min\left\{1, \frac{\lambda_S}{1-\omega_S}\right\} Rf'(R\omega_S),$$

and from N to S otherwise.

- Matsuyama (Econometrica 2004) endogenizes ω through savings and dynamics. Get endogenous inequality (ex-ante identical countries ending up with unequal wealth).

- Bottom line: possible to have a model where a dollar invested in S yields the same return of a dollar invested in N, and still the difference in MPKs is explained by credit market imperfections.

- Mechanism is that credit-market imperfections lead the borrower to expropriate the lender more in S (either because of lower λ, or because of lower ω - i.e. more leverage)

- Entrepreneurs are better off in S[‡]. Also, entrepreneurs are more leveraged in S.

[‡]Entrepreneurial income is

$$Rf'(k) - r(1-\omega) = Rf'(k) - \frac{\lambda}{1-\omega} Rf'(k)(1-\omega) = (1-\lambda)Rf'(k).$$

Recall that k is increasing in λ and ω.

Appendix: Development Accounting

- If

$$\text{Income} = F(\text{Factors,Efficiency}),$$

how much of Var(Income) is explained by Factors, and how much by Efficiency?

- There are two main approaches in the literature:

  - Estimation of F

    * Mankiw, Romer, and Weil (1992)

    * Islam (1995)

    * Caselli, Esquivel, and Lefort (1996)

- Calibration of F
  - King and Levine (1994)
  - Klenow and Rodriguez-Clare (1997)
  - Prescott (1998)
  - Hall and Jones (1999)

- Development-accounting increasingly uses the calibration approach.

Benchmark Calculation

- Use PWT6 (instead of PWT56). World income distribution in 1996 (instead of 1988). 93 countries. USA richest, (then) Zaire poorest.

- Model:

$$Y = AK^{\alpha}(Lh)^{1-\alpha},$$

or (dividing by L)

$$y = Ak^{\alpha}h^{1-\alpha},$$

- Measurement of Factors.

  – For k use perpetual inventory method ($K_t = (1-\delta)K_{t-1} + I_t$). I_t is from PWT, $\delta = 0.06$.

– For h use average years of education and Mincerian coefficients:

$$h = e^{\phi(s)},$$

where s is average years of schooling, and $\phi(s) = 0.13 \cdot s$ if $s \leq 4$, $\phi(s) = 0.13 \cdot 4 + 0.10 \cdot (s - 4)$ if $4 < s \leq 8$, $\phi(s) = 0.13 \cdot 4 + 0.10 \cdot 4 + 0.07 \cdot (s - 8)$ if $8 < s$.

– Interpretation:

* $w(s_i)$ is wage of a worker with s_i years of education. w_k is wage per unit of human capital. If $h = e^{\phi s}$, then $\log w(s_i) = \log(w_h e^{\phi s_i}) = \log(w_h) + \phi s_i$

* Psacharopulos surveys of Mincerian regressions around the World says $\phi = 0.13$ in Africa, $\phi = 0.10$ in World, $\phi = 0.07$ in OECD.

• Calibration: $\alpha = 1/3$.

Benchmark Results

- Factor-Only model

$$y_{KH} = k^{\alpha} h^{1-\alpha}$$

$$y = A y_{KH},$$

- Thought Experiment: A constant.

- Measures of Success of the Factor-Only Model

$$success_1 = \frac{\mathrm{var}\left[\log(y_{KH})\right]}{\mathrm{var}\left[\log(y)\right]}.$$

$$success_2 = \frac{y_{KH}^{90}/y_{KH}^{10}}{y^{90}/y^{10}},$$

var[log(y)]	1.246	y^{90}/y^{10}	20
var[log(y_{KH})]	0.501	y^{90}_{KH}/y^{10}_{KH}	7
$sucess_1$	0.40	$sucess_2$	0.35

Table 1: Baseline Success of the Factor-Only Model

- Upshot: investment rates and schooling (appropriately weighted) just don't vary enough across countries to explain the huge differences in incomes.

Basic Robustness Checks

- Alternative δ, construction of k, data on s, choice of ϕ.
- Unmeasured differences in work hours and unemployment.
- Overestimate of market hours in developing countries.
- Experience.

- Capital Share

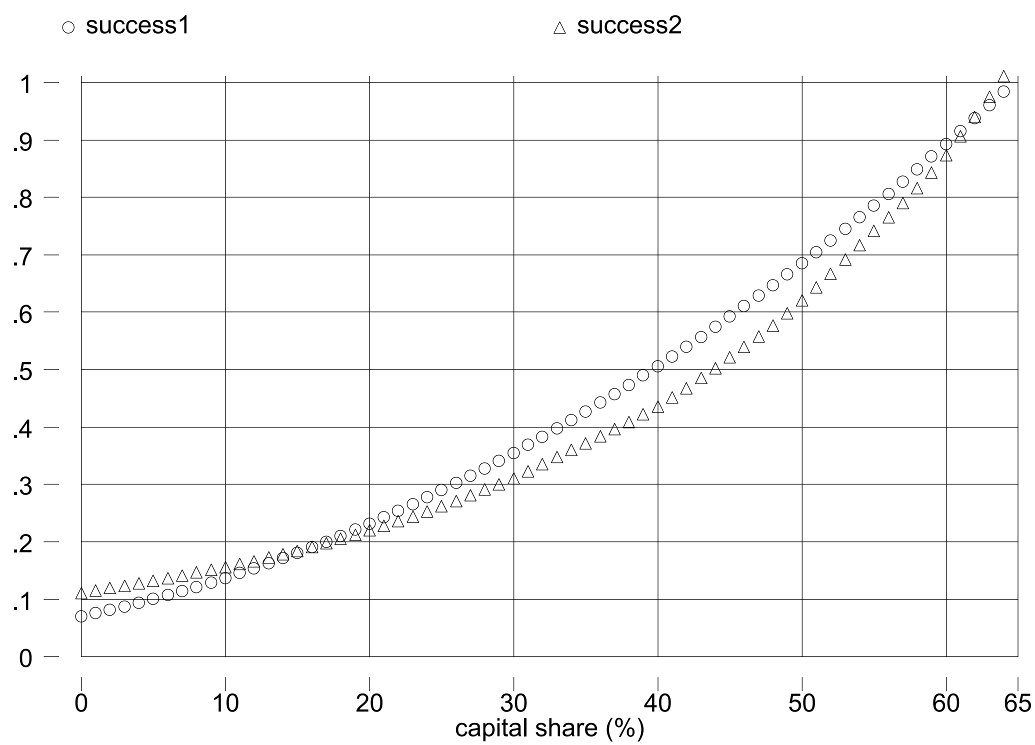


Figure 10: Capital Share and Success

Quality of Human Capital

Quality of education

- As measured by educational inputs
  - teachers' human capital
  - pupil-teacher ratio
  - school spending
- As measured by test scores.

Health (Weil, Shastry and Weil)

$$\begin{aligned} h &= A_h e^{\phi(s)} \\ A_h &= e^{-\phi_{amr} AMR}, \end{aligned}$$

where AMR is the "adult mortality rate," or the probability of "dying young." Weil's calibration: $-\phi_{amr}(\times 100) = 1.68$. Implies that 6 percent-

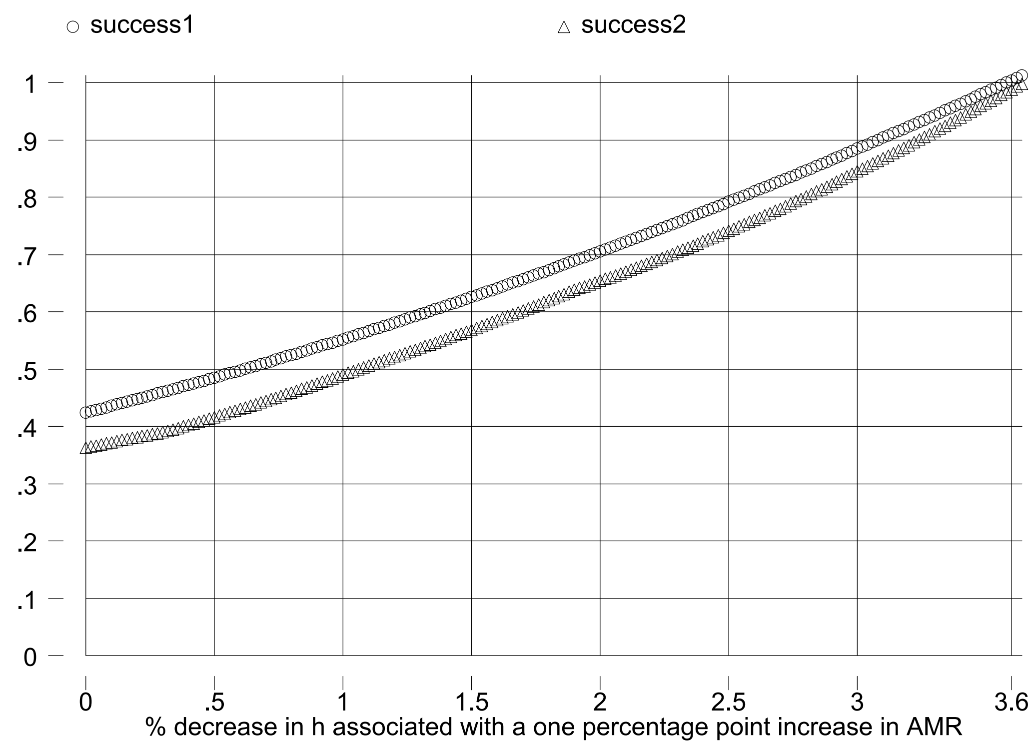


Figure 11: $-\phi_{amr}$ and Success

age points of AMR are equivalent to one extra year of schooling.