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The Marginal Product of Capital

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Is capital efficiently allocated across countries?

Yes, if MPK equalized

No, if MPK differs

This paper's answer: yes

First pass: one sector model

Constant returns and competitive markets

Capital Income in country $i = MPK^i$ x 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

First two estimates of MPK

Using total capital share

$$MPKN^i = \alpha_w^i \frac{Y^i}{K^i}$$

Using reproducible capital share

$$MPKL^i = \alpha_k^i \frac{Y^i}{K^i}$$

Second pass: 2-sector model

International cost of borrowing is R^*

Price of output is P_y^i

Price of equipment is P_k^i

Equipment-investment decision

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

Abstracting from capital gains

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

This rate-of-return equalization condition easily extends to J-sectors

Estimates 3 and 4

Total capital share with price correction

$$PMPKN^i = \frac{\alpha_w^i P_y^i Y^i}{P_k^i K^i} = \frac{P_y^i}{P_k^i} MPKN^i,$$

Reproducible capital share with price correction

$$PMPKL^i = \frac{\alpha_k^i P_y^i Y^i}{P_k^i K^i} = \frac{P_y^i}{P_k^i} MPKL^i$$

Data

One cross-section: 1996

Y : real per worker, from PWT6.1

K : PIM, $\delta = 0.6$, I from PWT6.1

P_y, P_k : dollar price of a bundle of final/capital goods. PWT6.1

α_w^i : from Bernanke and Gurkaynak (2001), via Gollin (2002). 1-labor share. Various corrections to NA figures to deal with non-corporate sector

Data (cont.): Reproducible capital share

World Bank (2006): estimates of total wealth and its components (based on present value of estimated rents)

Figure 1: The Marginal Product of Capital

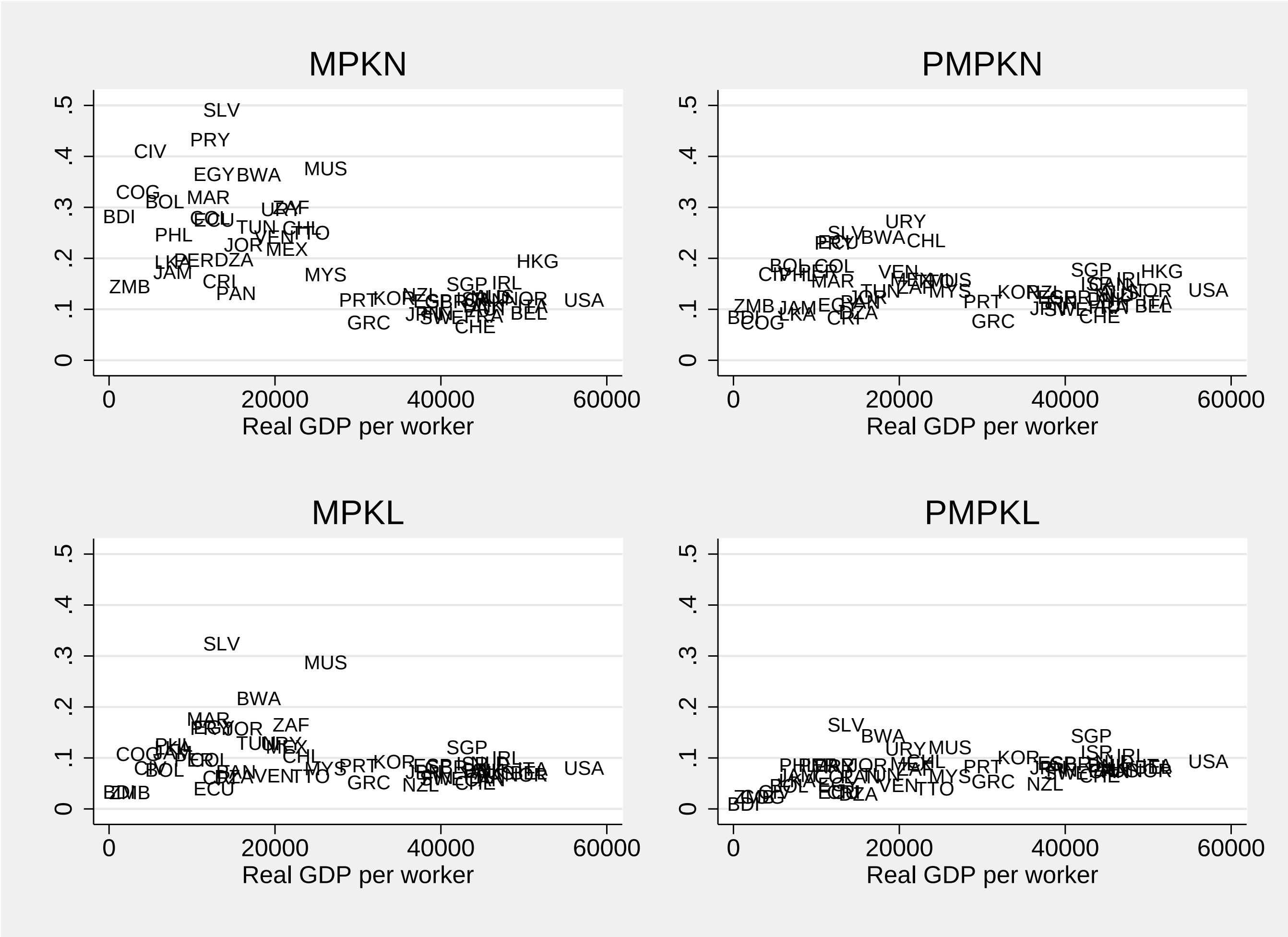


Table 1: Average Return to Capital in Poor and Rich Countries

	Rich Countries	Poor Countries
$MPKN$	11.4 (2.7)	27.2 (9.0)
$MPKL$	7.5 (1.7)	11.9 (6.9)
$PMPKN$	12.6 (2.5)	15.7 (5.5)
$PMPKL$	8.4 (1.9)	6.9 (3.7)

$MPKN$: naive estimate. $MPKL$: after correction for natural-capital. $PMPKN$: after correction for price differences. $PMKL$: after both corrections. Rich (Poor): GDP at least as large (smaller than) Portugal. Standard Deviations in Parentheses. Authors' calculations.

Deadweight loss calculation

Counterfactual world distribution of k and y if existing K redistributed to equalize MPKs

Answer: very small changes, and trivial world GDP gain

Conclusions

Lucas was right: credit frictions in international markets do not explain why poor countries do not receive capital

Capital does not flow to poor countries because of low TFP, low human capital, and low P_y/P_k

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

Deadweight loss calculation

Counterfactual world GDP if existing K redistributed to equalize MPKs

(Abstract from changes in aggregate K)

(Not a normative exercise!)

Have to assume Cobb-Douglas

$$Y_{ij} = Z_{ij}^{\beta_{ij}} K_{ij}^{\alpha_i} (X_{ij} L_{ij})^{1-\alpha_i-\beta_{ij}}$$

Domestic and international no arbitrage

$$\frac{P_{ij}}{P_k} \alpha_i Z_{ij}^{\beta_{ij}} (K_{ij}^*)^{\alpha_i - 1} (X_{ij} L_{ij})^{1-\alpha_i-\beta_{ij}} = PMPK^*$$

Dividing last two

$$K_{ij}^* = \left(\frac{PMPK^*}{PMPK_i} \right)^{\frac{1}{1-\alpha_i}} K_{ij}$$

(Hence Z_{ij}, and L_{ij} indeed unchanged). Aggregating across sectors

$$K_i^* = \sum_j K_{ij}^* = \sum_j \left(\frac{PMPK^*}{PMPK_i} \right)^{\frac{1}{1-\alpha_i}} K_{ij} = \left(\frac{PMPK^*}{PMPK_i} \right)^{\frac{1}{1-\alpha_i}} K_i$$

Aggregating across countries

$$\sum K_i^* = \sum K_i = \left(\frac{PMPK^*}{PMPK_i} \right)^{\frac{1}{1-\alpha_i}} K_i.$$

Solve for $PMPK^*$ and then compute K_i^* and Y_i^*

Figure 2:

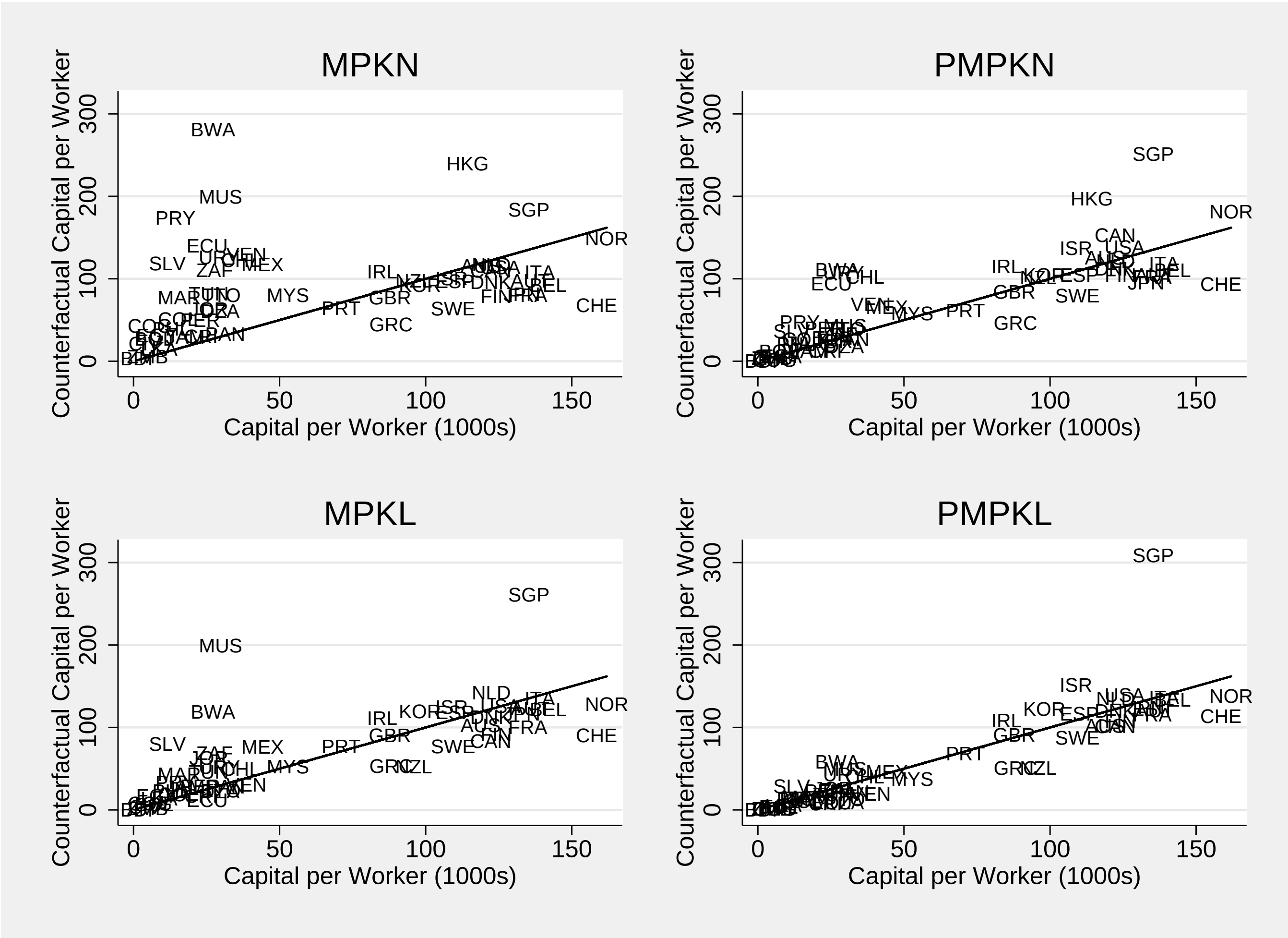

MPKN
PMPKN
MPKL
PMPKL
Counterfactual Capital per Worker
Capital per Worker (1000s)
0
50
100
150
200
300

Table 2: Average Changes in Equilibrium Capital Stocks under MPK Equalization

	Unweighted		Weighted by Population	
	Rich Countries	Poor Countries	Rich Countries	Poor Countries
$MPKN$	-12.9%	274.5%	-19.3%	205.8%
$MPKL$	-6.2%	86.6%	-5.6%	59.3%
$PMPKN$	0.1%	71.8%	-4.9%	52.0%
$PMPKL$	0.6%	-10.6%	1.4%	-14.5%

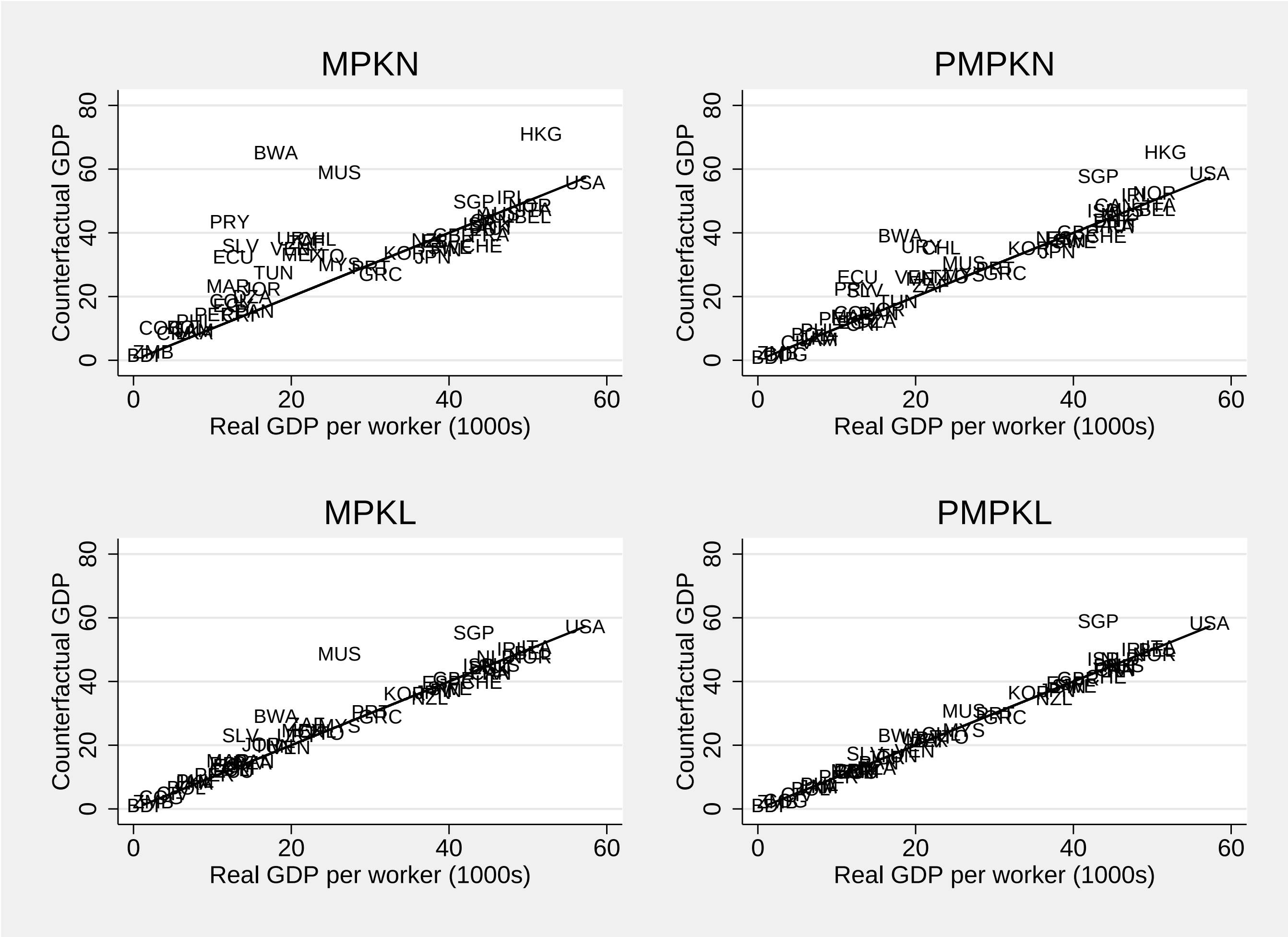
Notes: see Table 1

Counterfactual Output

$$Y_{ij}^{*} = Z_{ij}^{\beta_{ij}}(K_{ij}^{*})^{\alpha_i}(X_{ij}L_{ij})^{1-\alpha_i-\beta_{ij}} = \left(\frac{PMPK^{*}}{PMPK_i}\right)^{\frac{\alpha_i}{1-\alpha_i}} Y_{ij}$$

$$Y_i^{*} = \left(\frac{PMPK^{*}}{PMPK_i}\right)^{\frac{\alpha_i}{1-\alpha_i}} Y_i$$

Figure 3:



MPKN
PMPKN
MPKL
PMPKL
Counterfactual GDP
Real GDP per worker (1000s)

Table 3: Average Changes in Equilibrium Output per Worker under MPK Equalization

	Unweighted		Weighted by Population	
	Rich Countries	Poor Countries	Rich Countries	Poor Countries
$MPKN$	-3.0%	76.7%	-5.5%	58.2%
$MPKL$	-0.7%	16.8%	-1.0%	10.4%
$PMPKN$	1.1%	24.7%	-1.0%	17.4%
$PMPKL$	0.7%	0.0%	0.4%	-2.4%

Notes: see Table 1

Dead Weight Losses

$$\frac{\sum(Y^* - Y)}{\sum Y}.$$

Table 4: World Output Gain from MPK Equalization

	No Price Adjustment	With Price Adjustment
No Natural-Capital Adjustment	2.9%	1.4%
With Natural-Capital Adjustment	0.6%	0.1%

Authors' calculations.

Table 5: Counterfactual MPK under MPK Equalization

	No Price Adjustment	With Price Adjustment
No Natural-Capital Adjustment	12.7%	12.8%
With Natural-Capital Adjustment	8.0%	8.6%

Authors' calculations.

Back to Lucas

$$k_i^* = \Pi_i \times \Lambda_i,$$

where

$$\Pi_i = \left(\frac{\alpha_i}{PMPK^*} \frac{P_{y,i}}{P_{k,i}} \right)^{\frac{1}{1-\alpha_i}},$$

and

$$\Lambda_i = \left[z_i^{\beta_i} (X_i)^{1-\alpha_i-\beta_i} \right]^{\frac{1}{1-\alpha_i}},$$

$$var\left[\log(k^*)\right] = var\left[\log(\Pi)\right] + var\left[\log(\Lambda)\right] + 2 * cov\left[\log(\Pi), \log(\Lambda)\right]$$

Splitting covariance, contributions are 54% and 46%

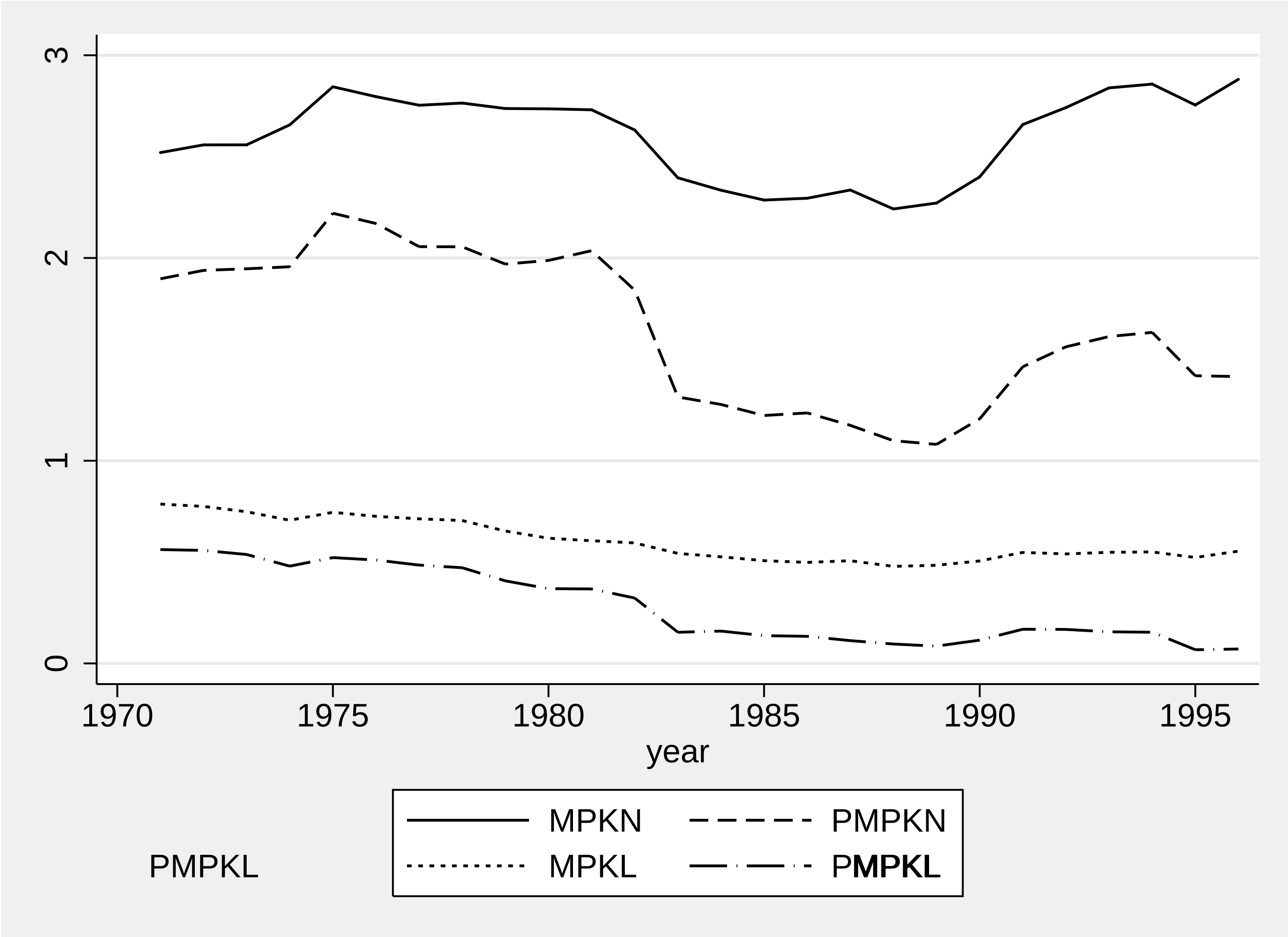
Theories of P_y/P_k

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

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

Time Series Results

Figure 4: The Dead Weight Loss of MPK Differentials



Notes: see Figure 1