14.581: International Trade
— Lecture 21—
Trade and Growth (Empirics II)

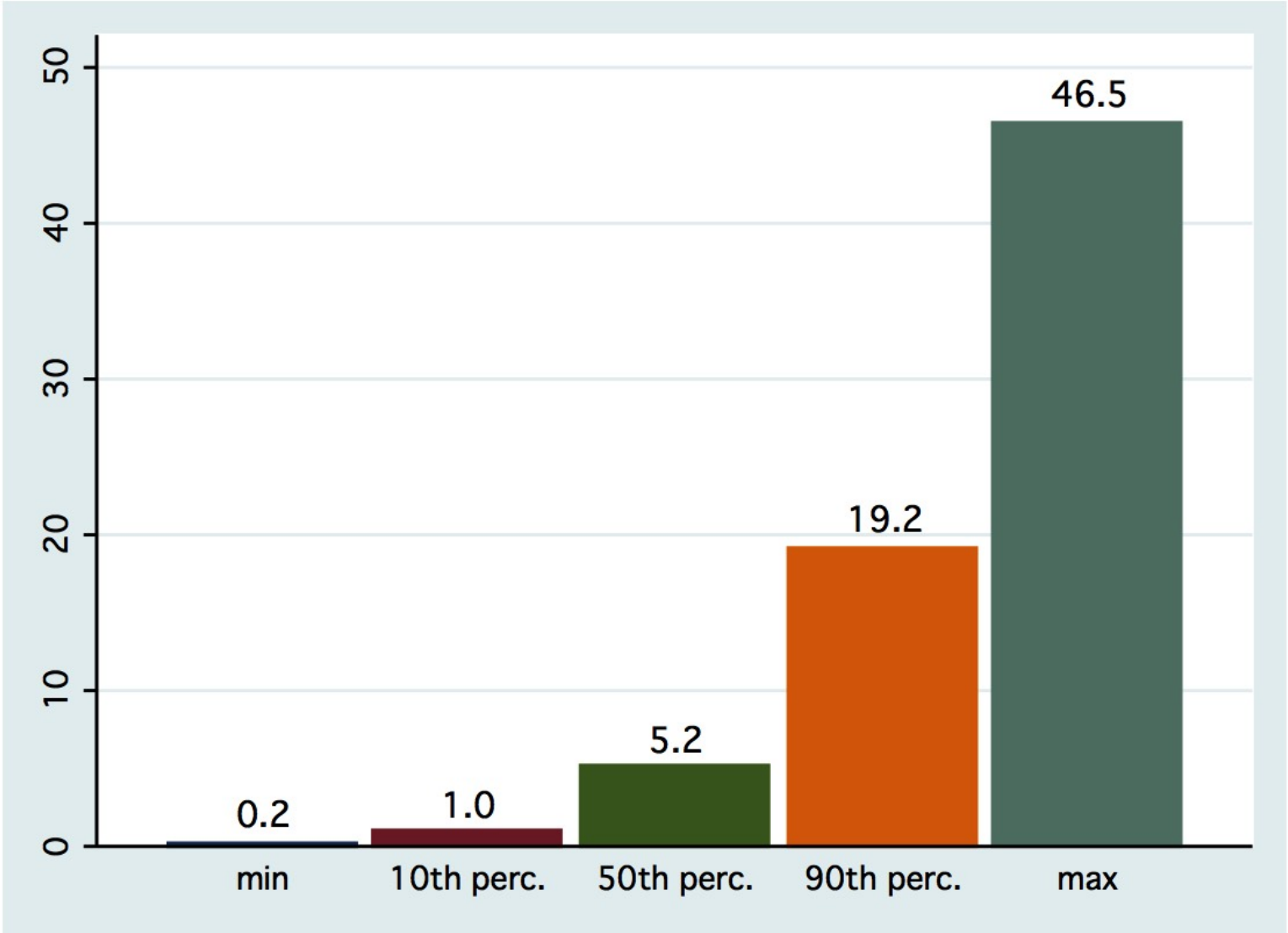
Today's Plan

1. Development Accounting
2. Gains from Financial Integration: Static Considerations
3. Gains from Financial Integration: Dynamic Considerations
4. Comparison with the Gains from Trade

1. Development Accounting

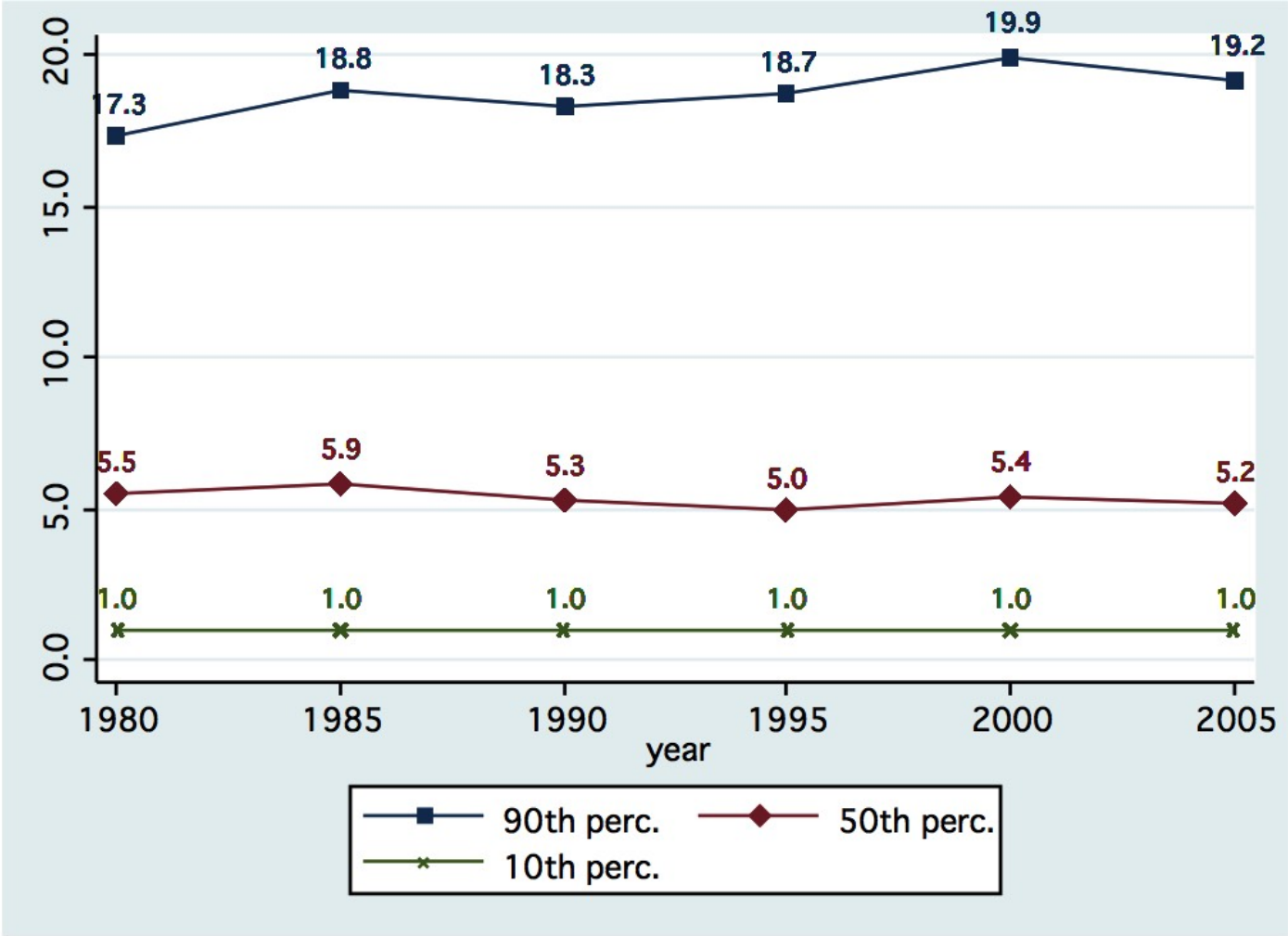
Income Differences Across Countries Are Large

Source: Caselli (2010). Income per capita in thousands of U.S. dollars



Income Differences Across Countries Are Persistent

Source: Caselli (2010). Income per capita in thousands of U.S. dollars



What Determines Income Differences Across Countries?

Hsieh and Klenow's (2010) Chain of Causality

$$\textit{Geography, Climate, Luck} \Rightarrow \textit{Human Capital, Physical Capital, TFP} \Rightarrow \textit{Income}$$
$$\Downarrow$$
$$\textit{Institutions, Culture} \Rightarrow \textit{Human Capital, Physical Capital, TFP} \Rightarrow \textit{Income}$$
$$\Downarrow$$
$$\textit{Policies, Rule of Law, Corruption} \Rightarrow \textit{Human Capital, Physical Capital, TFP} \Rightarrow \textit{Income}$$

Development Accounting

- **Central question in development accounting:**
  "What is the proximate role of physical capital, human capital in accounting for income differences across countries?"
- **Main question in this lecture:**
  How would (perfect) financial integration affect income across countries through its effect on physical capital around the world?
- Other possible benefits of financial integration:
  - Indirect effect on human capital (Gourinchas and Jeanne 2006)
  - Indirect effect on TFP (financial development, corporate governance)
  - Risk sharing (lower consumption volatility, but hard to find evidence)

- **Step 1:** Write output per worker in country i as

$$\frac{Y_i}{L_i} = A_i \left(\frac{K_i}{L_i}\right)^{\alpha} \left(\frac{H_i}{L_i}\right)^{1-\alpha} \tag{1}$$

or

$$\frac{Y_i}{L_i} = A_i^{1/(1-\alpha)} \left(\frac{K_i}{Y_i}\right)^{\alpha/(1-\alpha)} \left(\frac{H_i}{L_i}\right) \tag{2}$$

- **Step 2:** Take log on both sides, compute difference compared to US, and ask how much can be accounted for by observed factor differences, $\frac{K_i}{L_i}$ and $\frac{H_i}{L_i}$. Or do a variance decomposition.

Development Accounting

Current State of the Debate

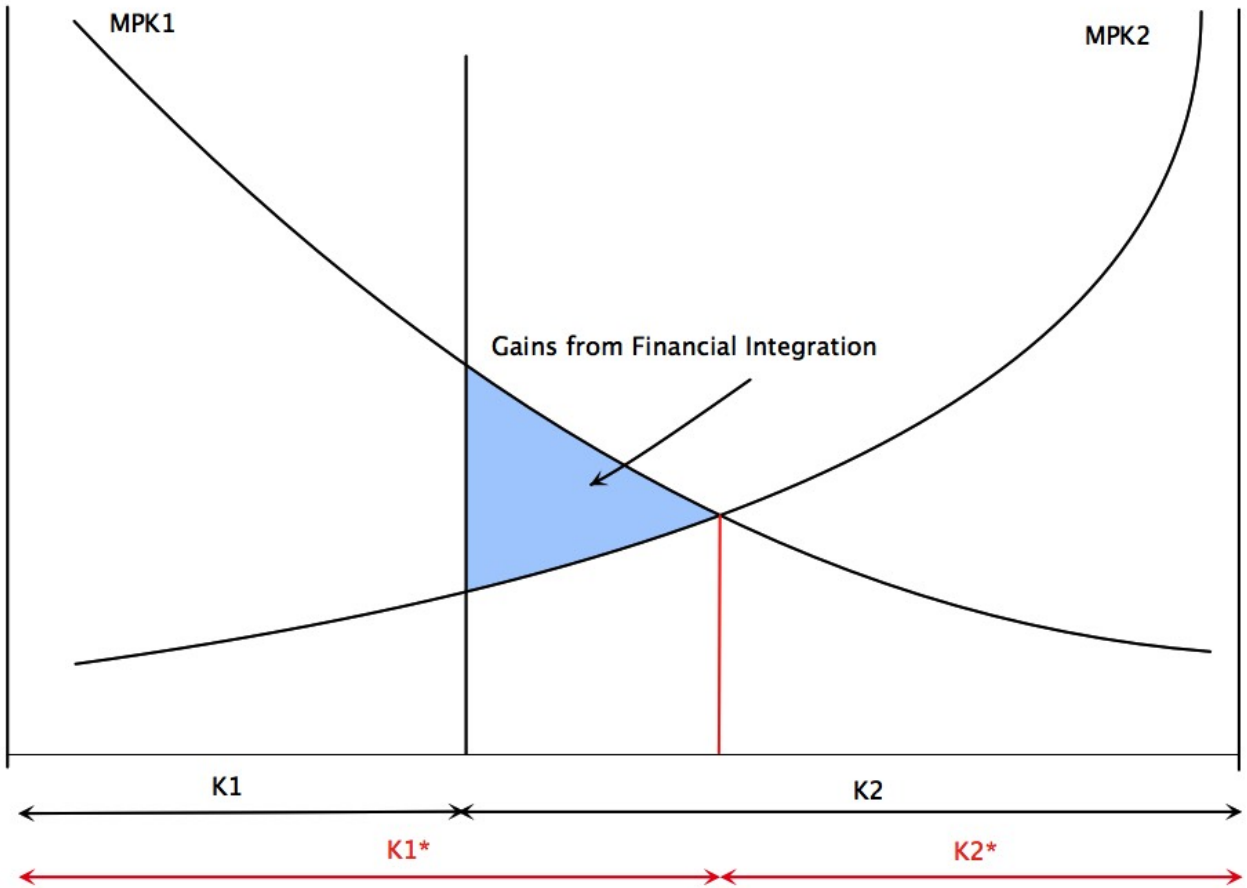
- Human capital is important: $\simeq$ 10-30% of country income differences
- Physical capital also matters: $\simeq$ 20% of country income differences
- Residual TFP is the biggest part of the story: $\simeq$ 50-70% of country income differences
  - this is true after accounting for $\neq$ in health and total hours worked
  - this is true whether one uses equation 1 or 2

- **Open question:** What determines A?
  - Recent research suggest misallocations may be important (Banerjee and Duflo 2005, Hsieh and Klenow 2009)
  - But what determines misallocations? Policy distortions, credit constraints, markups (Peters 2011)
- Easy to imagine in theory financial and trade integration affecting income through effects on misallocation and A (e.g. multinationals providing credit access to local subsidiaries?)
- Here, we focus on impact of financial integration on K/L

2. Gains from Financial Integration: Static Considerations

The Static Case for International Financial Integration

World output would be higher if MPKs were equalized



Differences in K/L Across Countries Are Large

So gains from financial integration might be large. Source: Caselli and Feyrer (2007)

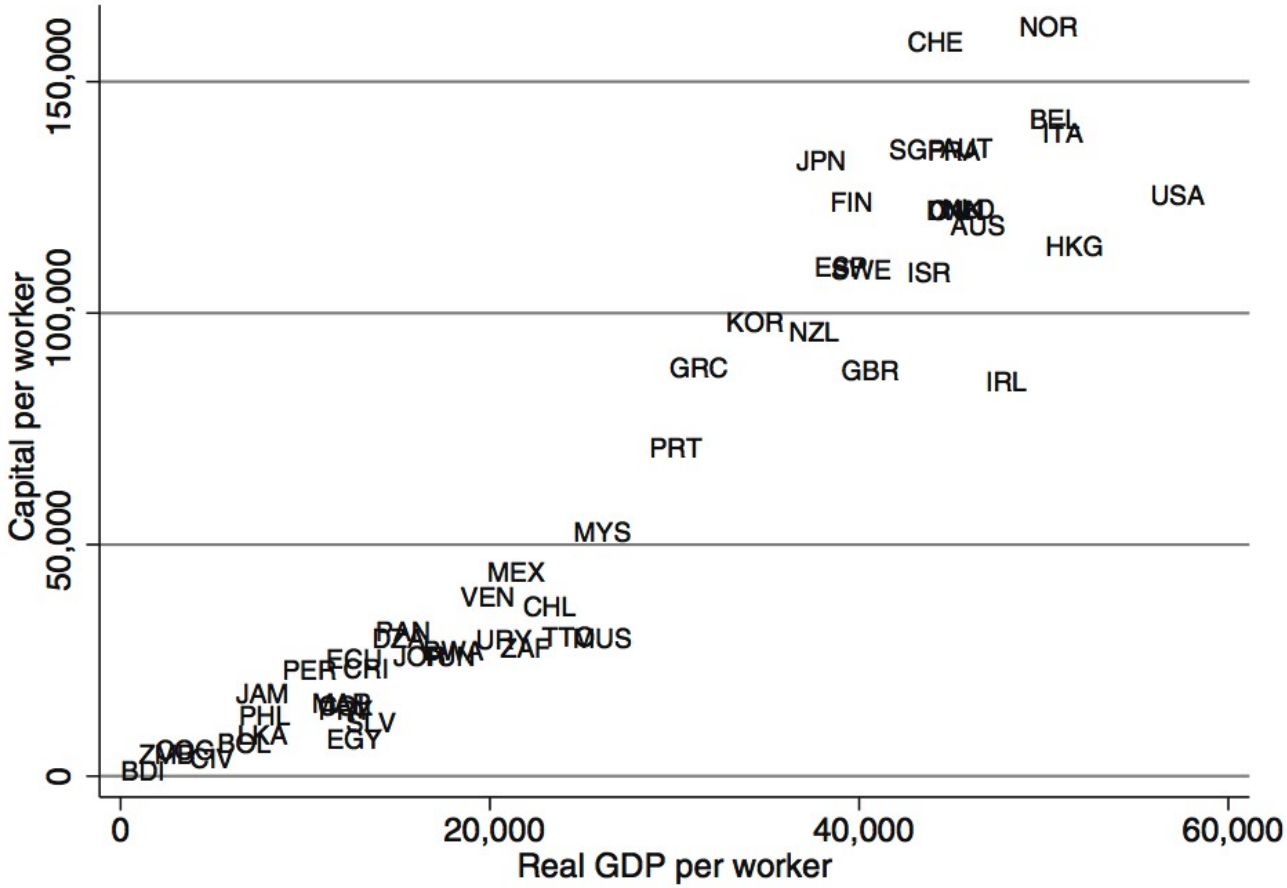


FIGURE I
Capital per Worker

Source: Penn World Tables 6.1.

But How Large Are Differences in MPK?

- Large $\neq$ in K/L do not necessarily imply large $\neq$ in MPK
  - Starting point of Lucas (1990)
- $\neq$ in MPK is key for size of gains from financial integration:
  - If $\neq$ in MPK are large, but "frictions" lead to small capital flows, then we should expect gains from (future) financial integration to be big
  - If $\neq$ in MPK are small, because $\neq$ in K/L reflect technological differences, then there may not be much left on the table
- Caselli and Feyrer (2007) demonstrate how to use easily access macroeconomic data to compute MPKs

Measuring MPK

Caselli and Feyrer (2007): Naive Approach

- Consider standard neoclassical environment:
  1. CRS
  2. Perfect competition
- Under CRS and perfect competition:

$$\text{Aggregate Capital Income} \equiv MPKN \times K$$

- Thus we can measure MPK using:

$$MPKN \times K = \alpha_w Y \Leftrightarrow MPKN = \frac{\alpha_w Y}{K}$$

where: $Y \equiv$ GDP; $\alpha_w \equiv 1-$Labor share in GDP; $K \equiv$ Capital stock

Measuring MPK

Caselli and Feyrer (2007): Land Corrected Measure

- What's naive about the naive approach?
  - $1-$labor share include payments accruing to both reproducible and non-reproducible capital, i.e., land and natural resources
  - But K, which is computed using using the perpetual inventory method from investment flows, represents only the reproducible capital stock
- Potentially important for cross-country $\neq$ in MPK:
  - Agricultural and natural-resource sectors represent a much larger share of GDP in poor countries
  - Thus we overestimate MPK (of reproducible capital) in those countries
- **New "Land corrected" measure:**

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

where $\alpha_k \equiv$share of reproducible capital in income

Measuring MPK

Caselli and Feyrer (2007): Price Corrected Measures

- The price of capital goods relative to consumption goods is also higher in poor countries (Hsieh and Klenow 2007)
  - Idea: Poor countries are relatively more efficient at producing consumption goods
  - (Question: So shouldn't they specialize in consumption goods and import capital goods?)
- Also important for cross-country $\neq$ in MPK:
  - For the purposes of cross-country capital flows, one wants to look at value of marginal product of capital, $\frac{\alpha P_y Y}{K}$, divided by its cost, P_k
  - If P_y / P_k is lower in poor countries, $\neq$ in physical MPK overestimate $\neq$ in returns to investment across countries
- **New "Price corrected" measures:**

$$PMPKN = \frac{\alpha_w P_y Y}{P_k K}, \; PMPKL = \frac{\alpha_k P_y Y}{P_k K}$$

where $P_y / P_k \equiv$price of consumption good relative to capital goods

How Do MPKs Vary Across Countries?

Caselli and Feyrer (2007)

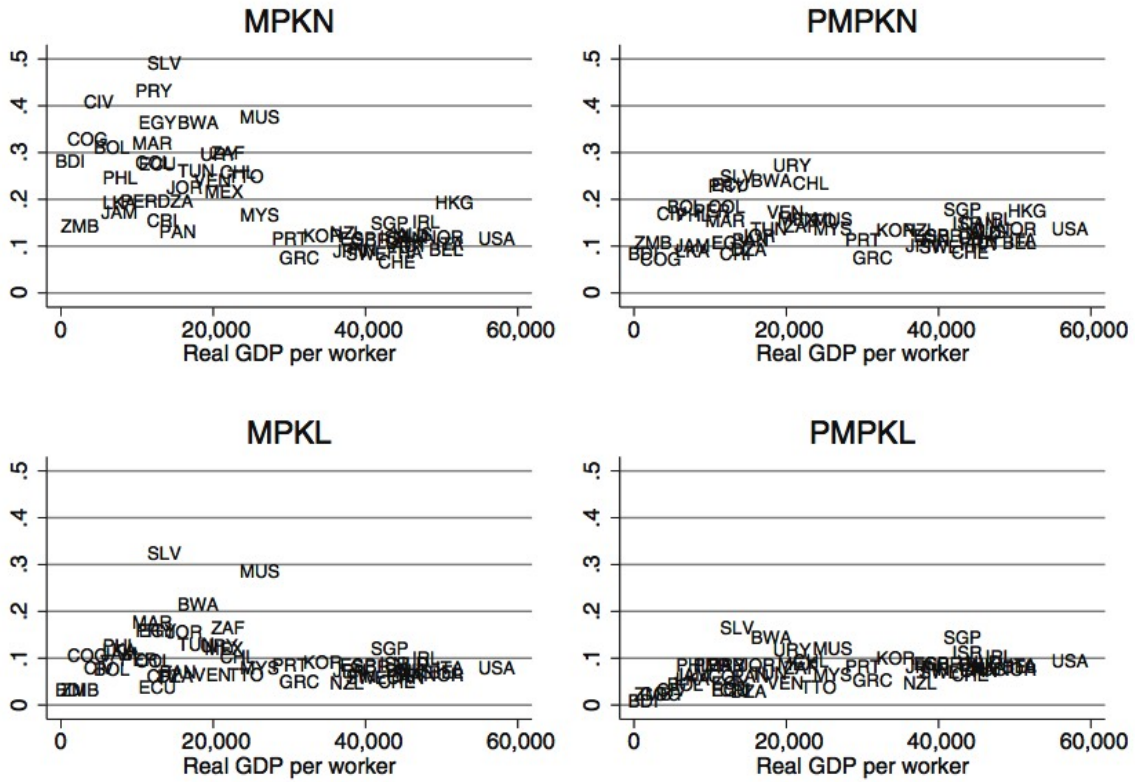


FIGURE V

The Marginal Product of Capital

MPK*N*, naive estimate; MPK*L*, after correction for natural-capital; *P*MPK*N*, after correction for price differences; *P*MPK*L*, after both corrections.

Source: Heston, Summers, and Aten [2004], Bernanke and Gurkaynak [2001], World Bank [2006], and authors' calculations.

How Do MPKs Vary Across Countries?

Caselli and Feyrer (2007)

TABLE III
AVERAGE RETURN TO CAPITAL IN POOR AND RICH COUNTRIES

	Rich countries	Poor countries
	11.4	27.2
MPK*N*	(2.7)	(9.0)
	7.5	11.9
MPK*L*	(1.7)	(6.9)
	12.6	15.7
*P*MPK*N*	(2.5)	(5.5)
	8.4	6.9
*P*MPK*L*	(1.9)	(3.7)

MPK*N*, naive estimate; MPK*L*, after correction for natural-capital; *P*MPK*N*, after correction for price differences; *P*MPK*L*, after both corrections; Rich (Poor), GDP at least as large (smaller than) Portugal. Standard deviations in parentheses.

Source: Authors' calculations.

So How Large Are the Gains From Financial Integration?

Caselli and Feyrer (2007)

- **Basic Message:**
  Since MPK—when measured correctly—are almost equal across countries, gains from financial integration cannot be that large
- Caselli and Feyrer (2007) proceed in two steps:
  1. Compute counterfactual capital stocks such that MPKs are equalized (perfect financial integration)
  2. Compute change in output associated with new stocks (gains from financial integration)

Counterfactual Capital Stocks

Caselli and Feyrer (2007)

- Assume Cobb-Douglas production function in country i:

$$Y_i = A_i \left(K_i\right)^{\alpha_i} \left(H_i\right)^{1-\alpha_i} \tag{3}$$

- Returns to investment in observed and counterfactual equilibria:

$$PMPK_i = \frac{\alpha p_{yi} A_i \left(H_i / K_i\right)^{1-\alpha_i}}{p_{ki}}, \; PMPK_i^* = \frac{\alpha p_{yi} A_i \left(H_i / K_i^*\right)^{1-\alpha_i}}{p_{ki}}$$

- In counterfactual equilibrium, $PMPK_i^* = PMPK^*$. Thus:

$$K_i^* = \left(\frac{PMPK_i}{PMPK^*}\right)^{1/(1-\alpha_i)} K_i \tag{4}$$

- Assuming fixed world capital stock, we can compute $PMPK^*$ s.t.:

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

Counterfactual Capital Stocks

Caselli and Feyrer (2007)

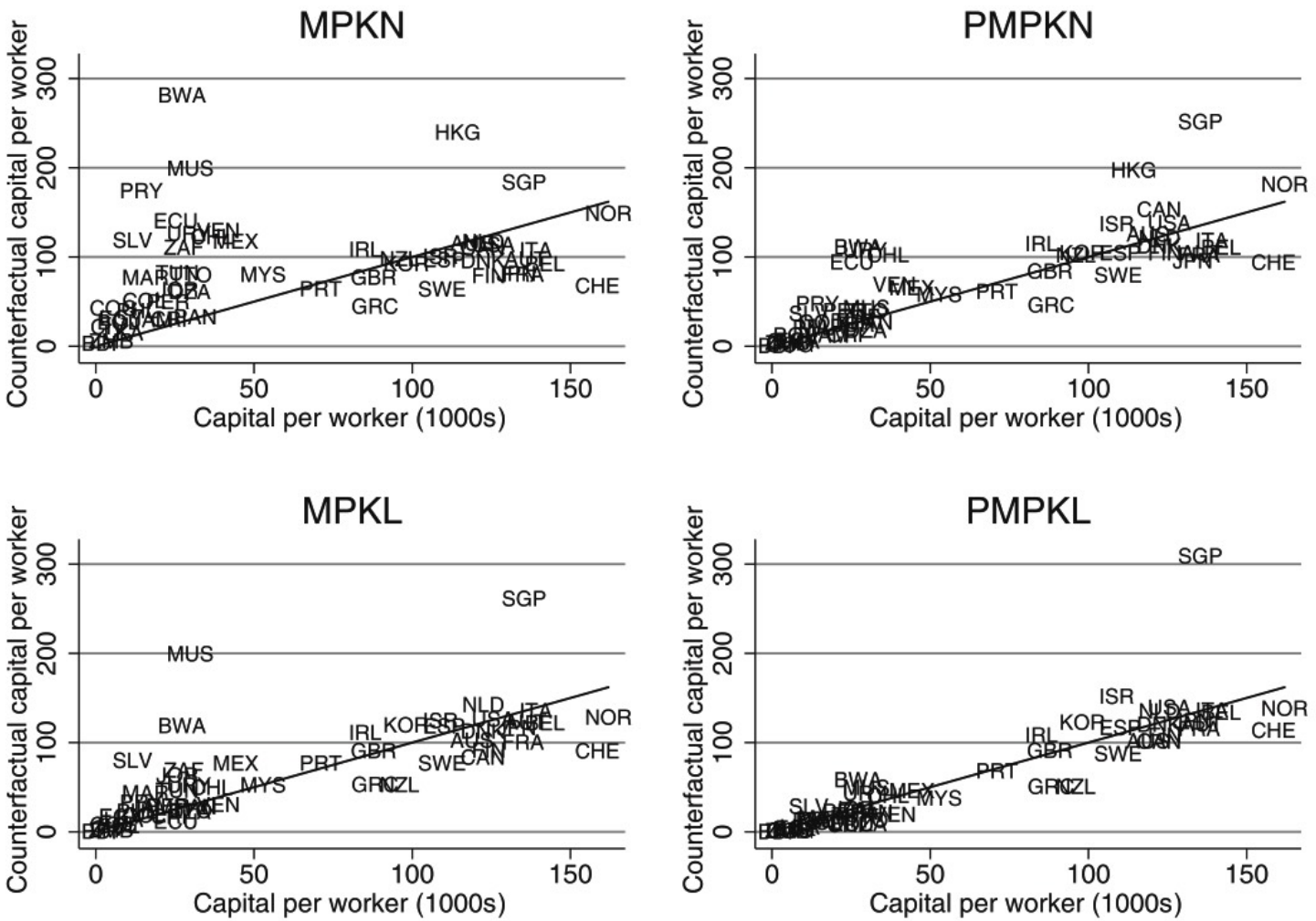


FIGURE VI
Counterfactual Capital per Worker with Equalized Returns to Capital

Counterfactual Capital Stocks

Caselli and Feyrer (2007)

TABLE IV

AVERAGE CHANGES IN EQUILIBRIUM CAPITAL STOCKS UNDER MPK EQUALIZATION

	Unweighted		Weighted by population	
	Rich countries	Poor countries	Rich countries	Poor countries
MPK*N*	−12.9%	274.5%	−19.3%	205.8%
MPK*L*	−6.2%	86.6%	−5.6%	59.3%
*P*MPK*N*	0.1%	71.8%	−4.9%	52.0%
*P*MPK*L*	0.6%	−10.6%	1.4%	−14.5%

MPK*N*, naive estimate; MPK*L*, after correction for natural-capital; *P*MPK*N*, after correction for price differences; *P*MPK*L*, after both corrections; Rich (Poor), GDP at least as large (smaller than) Portugal.

Source: Authors' calculations.

Counterfactual Output

Caselli and Feyrer (2007)

- Plugging counterfactual capital stock (4) into production function (3), we get counterfactual output:

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

- $PMPK_i$, $PMPK^*$ have been computed before
- α_i and Y_i are data

Counterfactual Output

Caselli and Feyrer (2007)

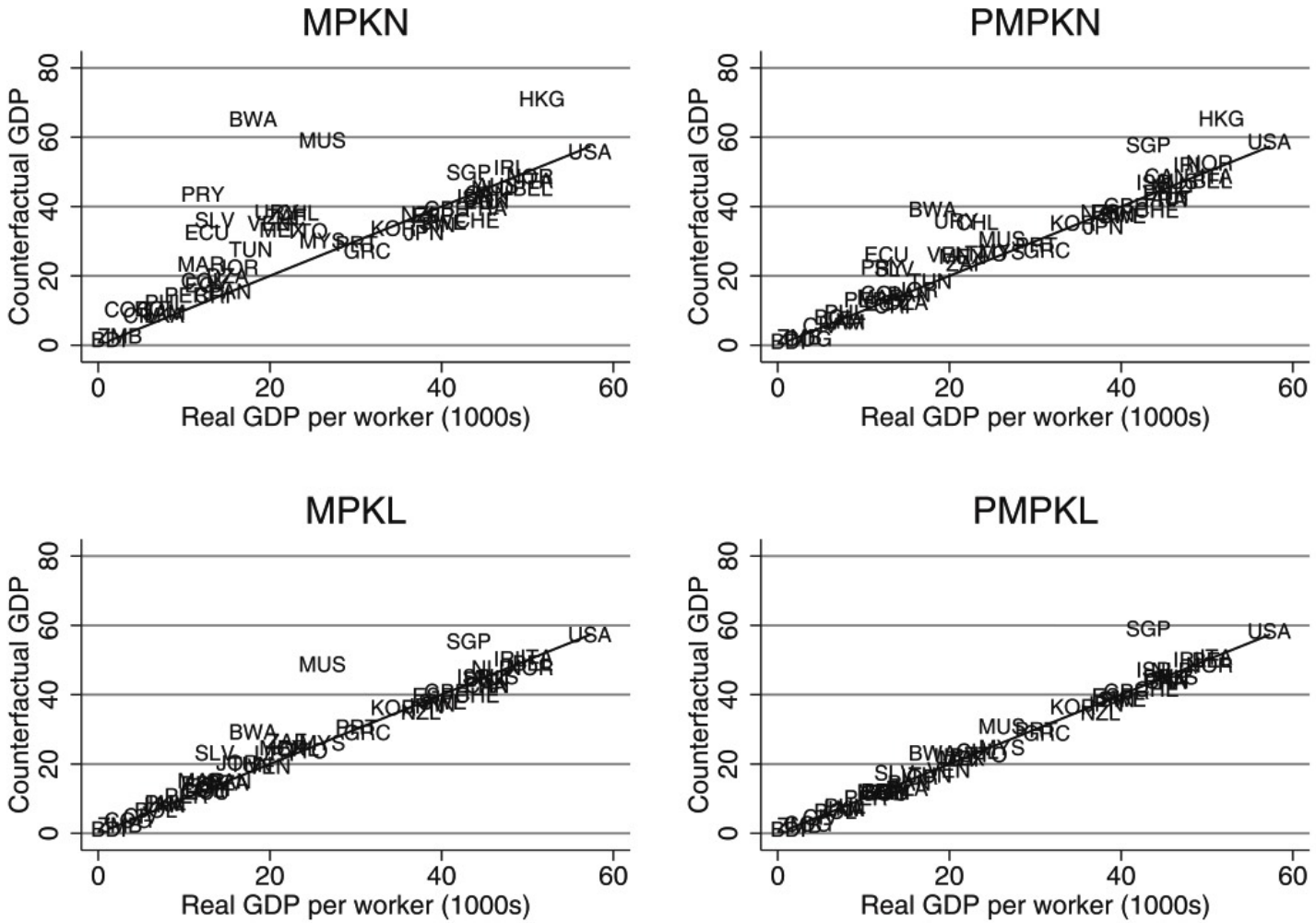


FIGURE VII
Counterfactual Output with Equalized Returns to Capital

Counterfactual Output

Caselli and Feyrer (2007)

TABLE V

AVERAGE CHANGES IN EQUILIBRIUM OUTPUT PER WORKER UNDER MPK EQUALIZATION

	Unweighted		Weighted by population	
	Rich countries	Poor countries	Rich countries	Poor countries
MPK*N*	−3.0%	76.7%	−5.5%	58.2%
MPK*L*	−0.7%	16.8%	−1.0%	10.4%
*P*MPK*N*	1.1%	24.7%	−1.0%	17.4%
*P*MPK*L*	0.7%	0.0%	0.4%	−2.4%

MPK*N*, naive estimate; MPK*L*, after correction for natural-capital; *P*MPK*N*, after correction for price differences; *P*MPK*L*, after both corrections; Rich (Poor), GDP at least as large (smaller than) Portugal.

Standard deviations in parentheses.

Source: Authors' calculations.

Gains From Financial Integration

Caselli and Feyrer (2007)

TABLE VI

WORLD OUTPUT GAIN FROM MPK EQUALIZATION

	No price adjustment	With price adjustment
No natural-capital adjustment	2.9%	1.4%
With natural-capital adjustments	0.6%	0.1%

Source: Authors' calculations.

Sources of Concern

Caselli and Feyrer (2007)

- Measurement issues are far from trivial
- We need accurate and comparable measures of:
  - quality-adjusted capital stocks
  - share of reproducible physical capital
  - quality-adjusted relative price of capital goods
- Microdata suggest that rate of return for additional investment in some firms in poor countries may be 100% (Banerjee and Duflo 2005)
  - But perhaps impossible to lend to those firms
  - So rate of return of additional foreign capital perhaps given by rate of return (much lower) for unconstrained firms
- Changes in output may be very different from changes in welfare:
  - most obvious when focusing on one country (when capital goes abroad, output goes down, but welfare goes up)
  - what about dynamic considerations?

A Final Reality Check

Caselli and Feyrer (2007)

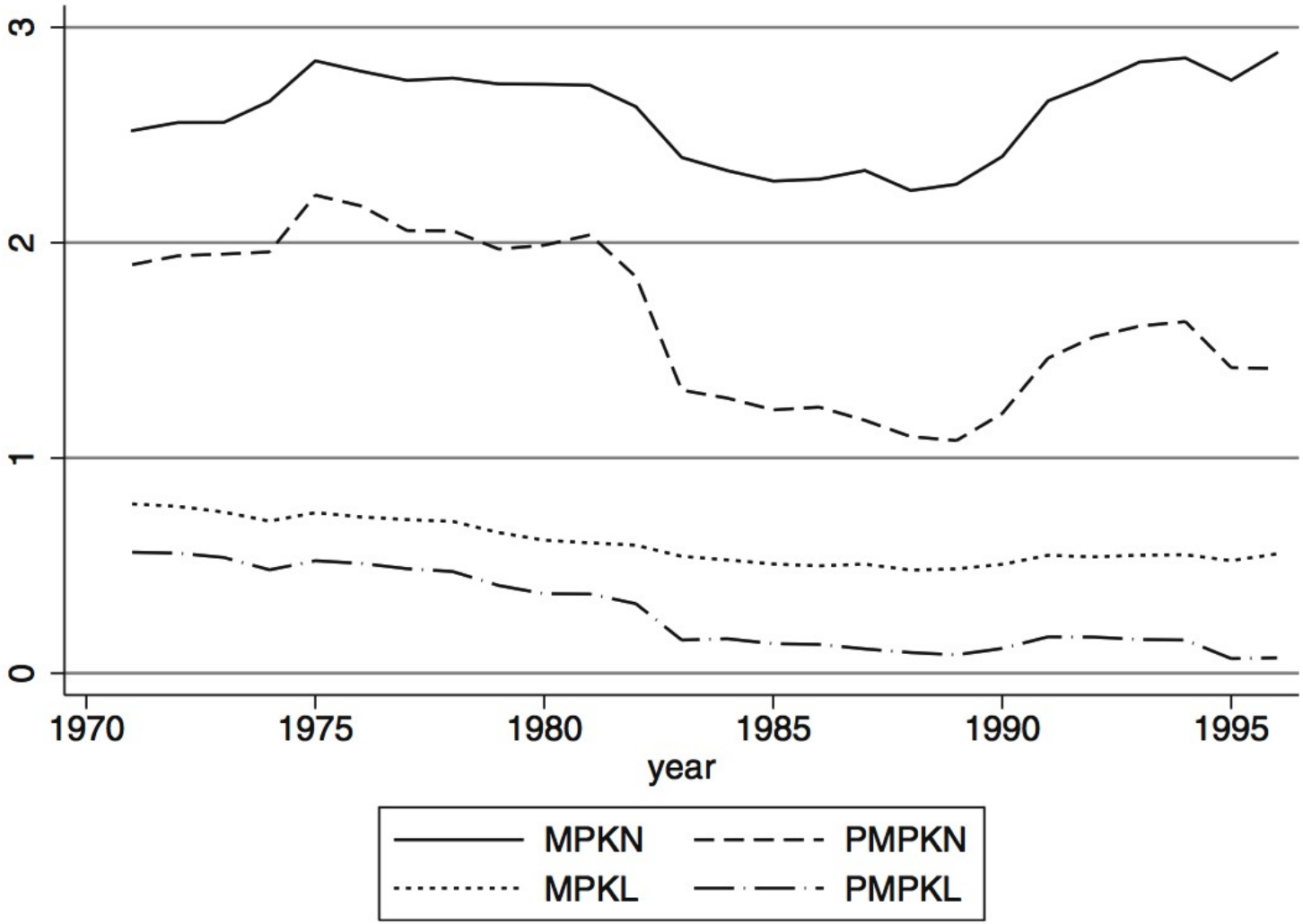


FIGURE VIII
The Dead Weight Loss of MPK Differentials (percent of world GDP)

3. Gains from Financial Integration: Dynamic Considerations

A Refresher on Neoclassical Growth Model

Preferences, Technology, and Market Structure

- Population grows at constant rate n:

$$N_t = n^t N_0$$

- Each household wishes to maximize

$$U = \sum_{t=0}^{\infty} \beta^t N_t \frac{c_t^{1-\gamma}}{1-\gamma}$$

subject to no-Ponzi condition and:

$$k_{t+1} - k_t = (r_t - \delta_k - n) k_t + w_t - c_t$$

- Final consumption good is produced according to

$$Y_t = K_t^{\alpha} (A_t N_t)^{1-\alpha} \Leftrightarrow y_t = k_t^{\alpha} A_t^{1-\alpha}$$

- Technological change occurs at a constant rate

$$A_t = (g^*)^t A_0$$

- All markets are perfectly competitive

- Euler equation:

$$c_t^{-\gamma} = \beta \left(r_{t+1} + 1 - \delta_k \right) c_{t+1}^{-\gamma} \tag{5}$$

- Firm profit maximization:

$$r_t = \alpha \left(A_t N_t / K_t \right)^{1-\alpha} \Leftrightarrow r_t = \alpha \left(k_t / A_t \right)^{\alpha - 1} \tag{6}$$

- Let $\tilde{c}_t \equiv c_t / A_t$ and $\tilde{k}_t \equiv k_t / A_t$. Along BGP:

$$\begin{aligned} (5) \quad &\Rightarrow \quad R^* \equiv r^* + 1 - \delta_k = \left(g^* \right)^{\gamma} / \beta \\ + (6) \quad &\Rightarrow \quad \left(\tilde{k}^* \right)^{\alpha - 1} = \left(\frac{\alpha}{\left(g^* \right)^{\gamma} / \beta + \delta_k - 1} \right)^{1/(1-\alpha)} \end{aligned}$$

A Refresher on Neoclassical Growth Model

Equilibrium Under (Perfect) Financial Integration

- Suppose that:
  - Rest of the world is identical, but already along BGP
  - Country is small compared to the rest of the world
- Under these two assumptions:
  - Gross rate of interest jumps to its equilibrium value R^*
  - Capital labor ratio (in effective units) jumps to its equilibrium value, $\tilde{k}^*$
- So financial integration accelerates convergence towards BGP
  - but BGP is the same as under autarky (except for interest payments)

So How Large Are the Gains From Financial Integration?

Gourinchas and Jeanne (2006)

- Let U_{aut} and U_{int} denote utility in the two equilibria
- The corresponding permanent consumption levels are given by

$$c_{aut} = \left[U_{aut} / \left(\sum_{t=0}^{\infty} \beta^t N_t / 1-\gamma\right)\right]^{1/(1-\gamma)},$$

$$c_{int} = \left[U_{int} / \left(\sum_{t=0}^{\infty} \beta^t N_t / 1-\gamma\right)\right]^{1/(1-\gamma)}$$

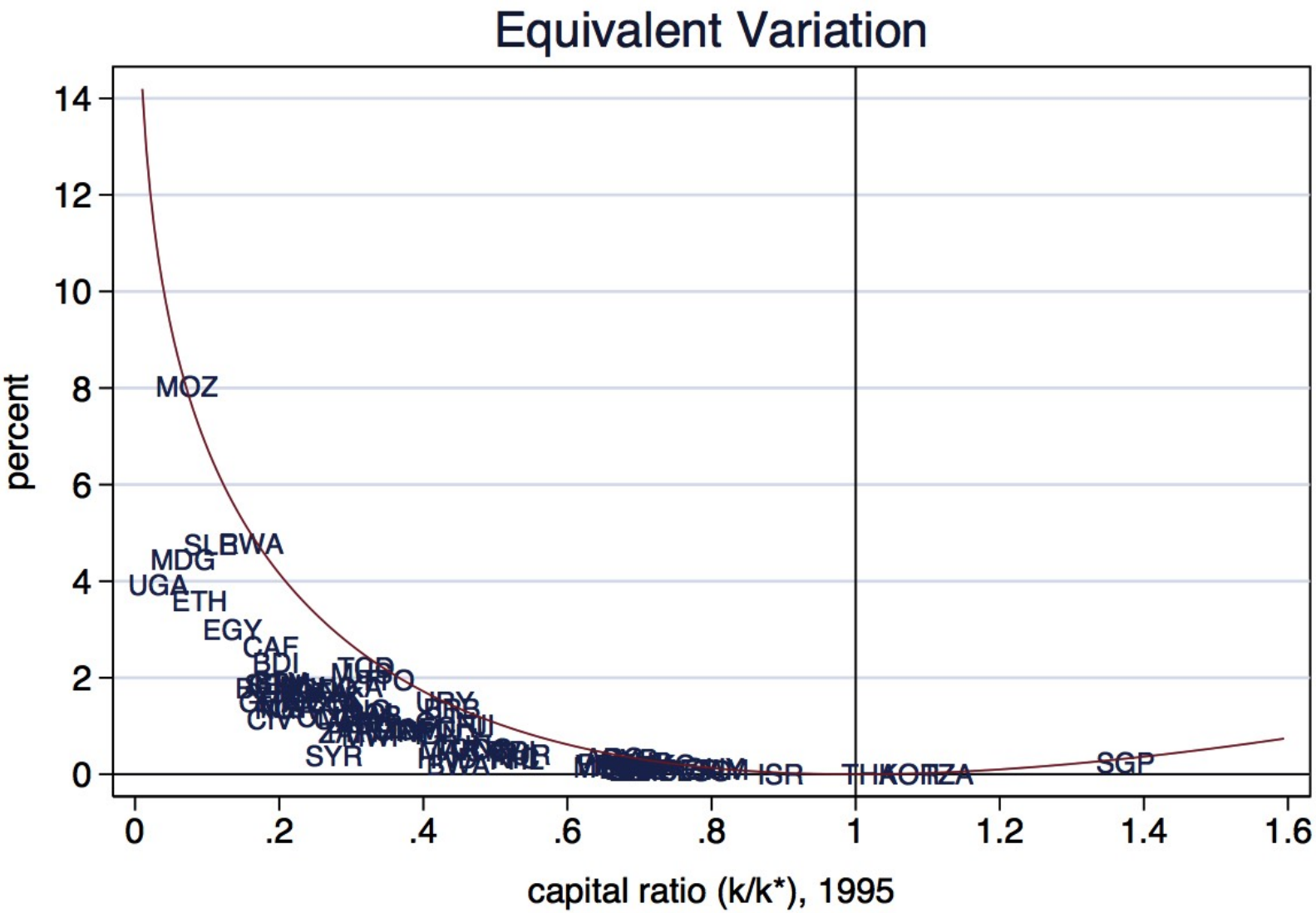
- Gains from Financial Integration measured as

$$\mu = \frac{c_{int}}{c_{aut}} - 1 = \left(\frac{U_{int}}{U_{aut}}\right)^{1/(1-\gamma)} - 1$$

- To measure these gains we need to calibrate the model:
  - $\beta = 0.96$, $\gamma = 1$, $\alpha = 0.3$
  - $\delta_k = 0.06$, $g^* = 1.012$, $n = 1.0074$

So How Large Are the Gains From Financial Integration?

Gourinchas and Jeanne (2006)



So How Large Are the Gains From Financial Integration?

Gourinchas and Jeanne (2006)

- **Basic Message:**
  Since the curve is very flat around k/k^*, countries need to be very far away from steady state to benefit from financial integration
- Gains from financial integration (again) are small, but logic is very different from Caselli and Feyrer (2007):
  - Here, capital integration may lead to large capital inflows initially
  - But because countries were converging to the same steady state
  - Capital flows would have been small in the future anyway
- Caution when interpreting (few) optimistic cross-country evidence:
  - Model is consistent with large initial increases in output
  - But even in such circumstances, welfare gains are small

Gains From Financial Integration in Perspective

Gourinchas and Jeanne (2006). Note: here model also allows for endogenous human capital accumulation

$$\left(\ln y_0 - \ln y^{*,US}\right) = \left(\ln \tilde{y}_0 - \ln \tilde{y}^*\right) + \left(\ln \tilde{y}^* - \ln \tilde{y}^{*,US}\right) + \left(\ln A'_0 - \ln A'^{US}_0\right)$$

TABLE 9

Development accounting

	$y_0/y_0^{*,\text{U.S.}}$ (1)	$\tilde{y}_0/\tilde{y}^*$ (2)	Physical capital (3)	Human capital (4)	Total $\tilde{y}^*/\tilde{y}^{*,\text{U.S.}}$ (5)	$A'_0/A'^{\text{U.S.}}_0$ (6)	Obs.
Non-OECD countries	0·11	0·15	0·08	0·20	0·28	0·58	65
Low income	0·07	0·13	0·11	0·20	0·31	0·56	24
Lower middle income	0·11	0·15	0·05	0·20	0·25	0·60	23
Upper middle income	0·24	0·15	0·11	0·19	0·29	0·56	13
High income	0·44	0·46	−0·22	0·17	−0·05	0·58	5
Africa	0·12	0·08	0·19	0·22	0·41	0·50	27
Asia	0·09	0·16	0·06	0·19	0·25	0·59	16
Latin America	0·21	0·13	0·13	0·20	0·32	0·55	22
Except China and India	0·15	0·14	0·11	0·21	0·31	0·55	63
China and India	0·07	0·15	0·06	0·19	0·25	0·60	2

$y_0/y_0^{*,\text{U.S.}}$ represents the development ratio (output *per capita* relative to U.S. steady-state output *per capita*); $\tilde{y}_0/\tilde{y}^*$ denotes the convergence ratio (ratio of output *per capita* to steady-state output per efficient capita); $\tilde{y}^*/\tilde{y}^{*,\text{U.S.}}$ denotes the distortion ratio (ratio of steady-state output per efficient capita to U.S.); finally, $A'_0/A'^{\text{U.S.}}_0$ denotes the productivity ratio. Columns (2)–(6) expressed as a share of the log development ratio. Population-weighted averages. Year is 1995.

Gains From Financial Integration in Perspective

Gourinchas and Jeanne (2006)

- Under financial autarky, model predicts that:

$$\left(\ln y_0 - \ln y^{*,US}\right)_{NON-OECD,aut} = \ln(0.11)$$

$$\left(\ln \tilde{y}_0 - \ln \tilde{y}^*\right)_{NON-OECD,aut} = 0.15 \times \left(\ln y_0 - \ln y^{*,US}\right)$$

- If financial integration only accelerates convergence to BGP:
  - $\left(\ln \tilde{y}_0 - \ln \tilde{y}^*\right)_{NON-OECD,int} = 0$
  - everything else is unchanged
- Under financial integration, we would go from $y_0/y^{*,US} = 0.11$ to

$$\left(\ln y_0 - \ln y^{*,US}\right)_{NON-OECD,int} = (1 - 0.15)\ln(0.11)$$

$$\Leftrightarrow y_0/y^{*,US} = (0.11)^{0.85} = 0.15$$

Summary

Gourinchas and Jeanne (2006)

- If capital mobility simply brings faster conditional convergence, it will not succeed in closing the gap between poor and rich countries
- Differences in standards of living arise mostly from differences in productivity and human capital, especially for the poorest countries
- **Policy implication:**
  - Even if capital flows were below the efficient level because of international credit rationing, the potential gains from mitigating this inefficiency might be quite moderate
  - Countries have much more to gain from upgrading their domestic engines of growth and development (e.g. by relaxing domestic credit rationing) than from attracting larger quantities of foreign capital per se
- *If* financial integration has large impact on welfare in poor countries, this must be through channels not in neoclassical growth model

4. Comparing Gains from Financial Integration and Gains from Trade

Measuring the Gains from Trade

Arkolakis, Costinot, and Rodriguez-Clare (2012)

- We characterize a particular, but important class of trade models
  - PC: Anderson '79, Anderson & van Wincoop '03, Eaton & Kortum '02
  - MC: Krugman '80 and many variations of Melitz '03
- Within that class, welfare changes are ($\hat{x} = x'/x$)

$$\hat{W} = \hat{\lambda}^{1/\varepsilon}$$

- Two sufficient statistics for welfare analysis are:
  - **Share of domestic expenditure**, λ;
  - **Trade elasticity,** ε

Some Numbers

- Consider Belgium and the United States
- What do trade data say?
  1. Share of domestic expenditure: $\lambda_{BEL} = 0.73$, $\lambda_{US} = 0.93$
  2. Trade elasticity: $\overline{\varepsilon} = -5$
- How large are the gains from trade?
  - Compute how much we would lose if were to go from λ to $\lambda' = 1$
  - $GT_{BEL} \equiv (0.73)^{-1/5} - 1 \simeq 6.5\%$
  - $GT_{US} \equiv (0.93)^{-1/5} - 1 \simeq 1.4\%$
- GT are about twice as large if one allows for intermediate goods
  - Importance of multiple sectors, monopolistic competition, and multiple factors also discussed in Costinot and Rodriguez-Clare (2013)

Gains from Financial Integration vs. Gains From Trade

Apples and Oranges?

- According to Gourinchas and Jeanne (2006), gains from financial integration around 1% for typical non-OECD country
- This is not very far from $GT_{US} = 1.4\%$, but there are important $\neq$:
  - Non-OECD v.s. US (gains from financial integration lower for US)
  - Thought experiments are not the same
  - ACR focus on *observed* equilibrium (λ is data)
  - Gourinchas and Jeanne (2006) focus on two hypothetical equilibria: autarky and perfect financial integration (upper-bound)
  - If we go from autarky to free trade, GT are much larger (Eaton and Kortum 2002 say 30%, but what do you make of a counterfactual world in which distance does not matter?)
- Perhaps more importantly, without trade in goods, there are no gains from financial integration...

Development Accounting Revisited

Waugh (2010)

- Waugh (2010) consider Eaton and Kortum (2002) with K and L
- Waugh (2010) show that real GDP in country i can be expressed as:

$$Y_i = A_i K^{\alpha} L^{1-\alpha}, \text{ with } A_i \propto \lambda_i^{(1-\gamma)/\varepsilon\beta}$$

- Same logic as in the formula for GT in ACR (β, γ are shares of intermediate goods for tradables and non-tradables)
- How important is trade for cross-country income differences?
  - not that much today, because GT are pretty small everywhere
  - perhaps tomorrow, because trade costs are larger for poor countries