Uncovering the Impact of Financial Development on Economic Development using General Equilibrium Modelling

Jeremy Greenwood and Juan M. Sanchez

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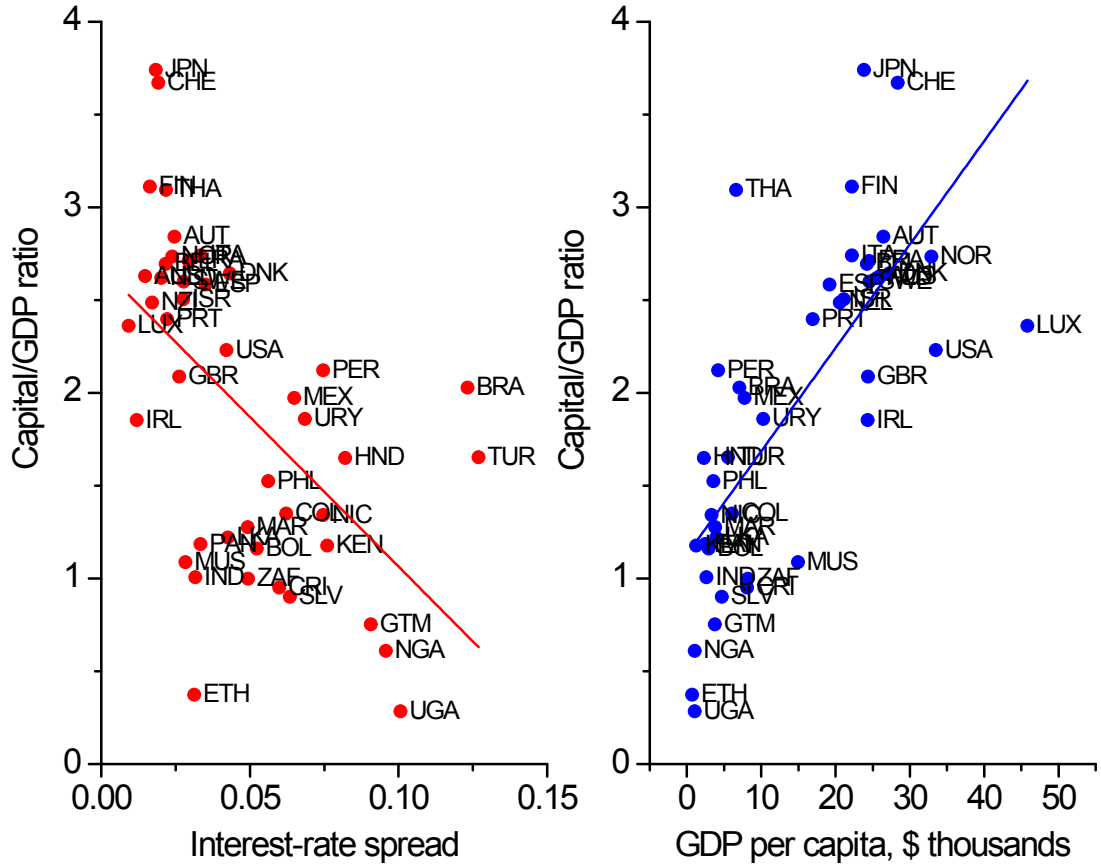
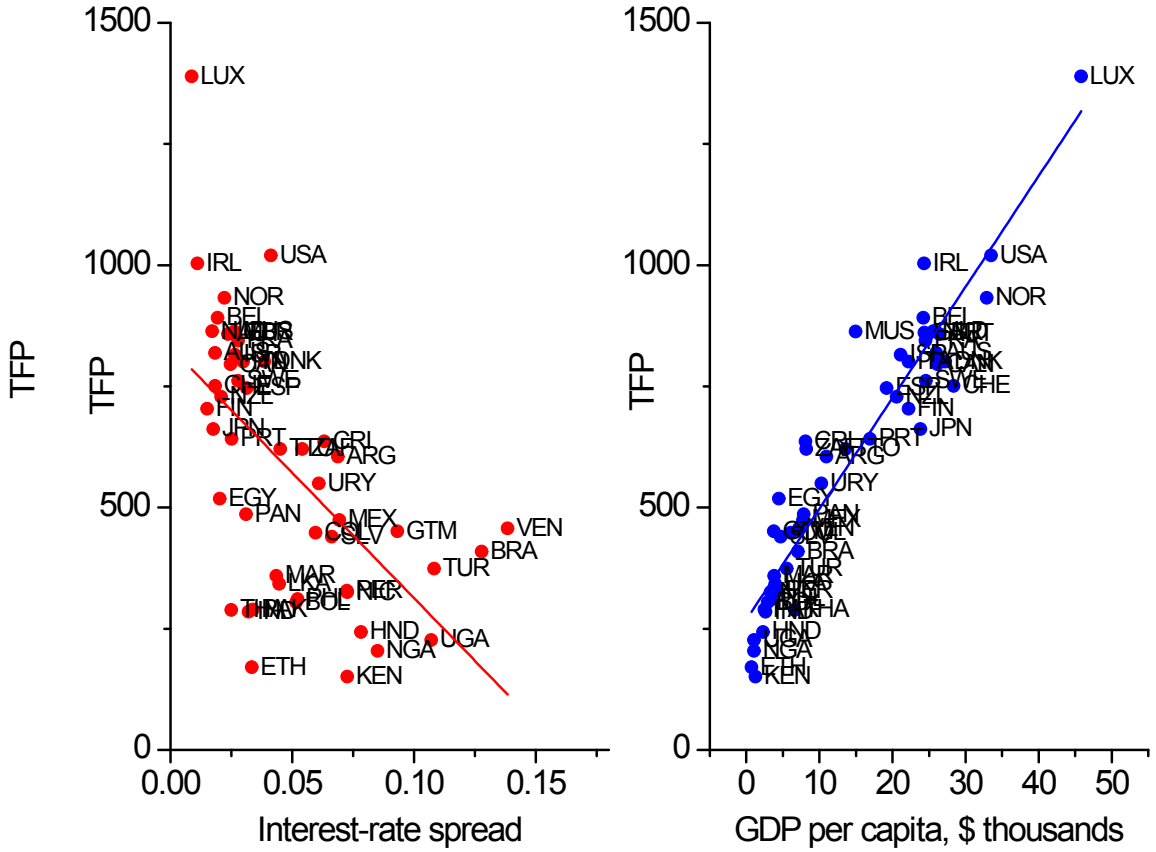
1 Introduction

- The efficiency of financial intermediation affects economic development through
  - *capital deepening*
  - *reallocation* of labor and capital
  - *choice of technology*

- These effects are illustrated by the cross-country relationship between
  - interest-rate spreads
  - capital-to-output ratios and TFPs



Capital Deepening



Reallocation and Choice of Technology

- Differences in technology adopted reflected by differences in establishments across countries
  - Plants are smaller in poorer countries
  - Plants have lower TFP in poorer countries
  - Older plants account for more employment in richer countries
  - In richer countries older plants have higher TFP relative to younger ones

Stylized Facts: India, Mexico, and the U.S.

Statistics	*U.S.*	*Mexico*	*India*
Output per worker	1.00	0.33	0.12
TFP	1.00	0.46	0.24
Average establishment size	1.00	0.55	0.11
Empl share, age ≤ 10	0.25	0.52	0.51
$\ln(\text{TFP}_{age>35}) - \ln(\text{TFP}_{age<5})$	2.23	0.51	0.30

2 Theory

- A Model of Firms and Intermediaries
- Costly State Verification Model a la Townsend (1979)
- Two twists
  - Efficiency of Monitoring
    - Depends upon resources devoted to it
    - Depends upon efficiency in financial sector
  - Ex ante firm heterogeneity in risk and return

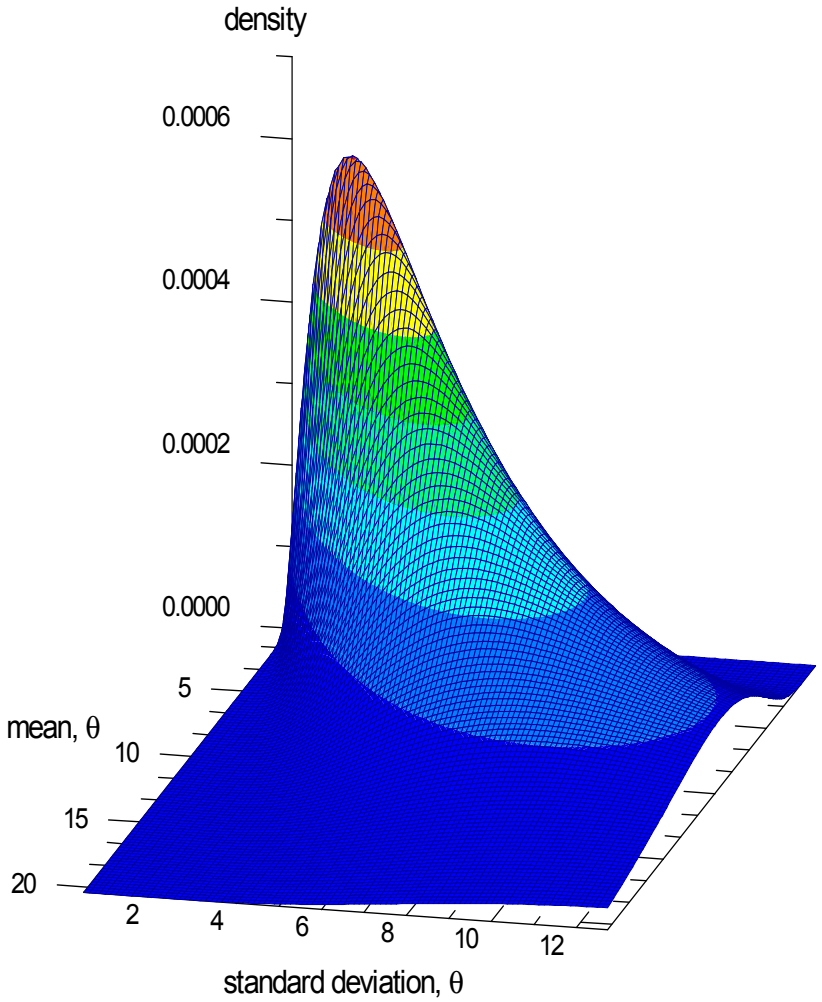
3 Firms

- Produce output,

$$o = x\theta k^{\alpha} l^{1-\alpha}$$

  - $\theta \in \{\theta_1, \theta_2\}$, with $\theta_2 > \theta_1$
  - $\pi_1 = \mathsf{Pr}(\theta = \theta_1)$ and $\pi_2 = 1 - \pi_1 = \mathsf{Pr}(\theta = \theta_2)$
  - realization is private information
  - $\tau = (\theta_1, \theta_2)$, is the firm's publicly observable type
  - $\mathcal{T}$, space of firm types
  - $\tau \sim F : \mathcal{T} \to [0, 1]$

– x is a country-specific level of TFP



The F distribution – in mean/variance space

4 Intermediaries

Borrow from consumers and lend to firms

- k, size of loan to firm (capital)
- p's, payments from firm to intermediary
- θ_j, state reported by firm
- θ_i, true state realized by firm

- l_{mj}, labor devoted to monitoring a claim of state j

- z, efficiency in financial sector productivity

4.1 Monitoring Technology

- $P_{ij}(l_{mj}, k, z)$, probability that the firm is caught *cheating* (for $i \neq j$) when:
  - true realization of productivity is θ_i
  - firm makes a *false* report of $\theta_j \neq \theta_i$
  - P_{ij} is increasing in l_{mj}
  - P_{ij} is decreasing in k
  - P_{ij} is increasing in z

5 Contracting Problem

5.1 Notation

- $\widetilde{r}$, cost of capital for the intermediary
  - return to savers plus capital consumption

- r_i, *internal* return on firm's capital in state i

$$r_i k = R(\theta, x, w)k \equiv \max_l \{x\theta k^{\alpha} l^{1-\alpha} - wl\}$$

5.2 The Contract

- Contract designed so that firms always tells the truth
  - Value of telling truth greater than value of telling a lie
- Intermediary takes everything upon a report of the bad state
  - $r_1(\tau)k$
- Intermediary audits all reports of a bad state
  - Takes all output if the firm is caught cheating, $r_2(\tau)k$

5.2.1 The Problem

$$\max_{k,l_{m1}} \{\underbrace{\pi_2[1 - P_{21}(l_{m1}, k, z)][r_2(\tau) - r_1(\tau)]k}_{\text{Return to Firm}}\},$$

subject to

$$\underbrace{[\pi_1 r_1(\tau) + \pi_2 r_2(\tau)]k - \pi_2[1 - P_{21}(l_{m1}, k, z)][r_2(\tau) - r_1(\tau)]k - \pi_1 w l_{m1} - \widetilde{r}k}_{\text{Return to Intermediary}}$$

$$= 0.$$

6 Baseline Calibration

- Model fit to U.S. economy
- Standard parameters given standard values
- Other parameters picked to minimize the distance between model and some data targets

- Data Targets, 1974 and 2004

  1. Establishment size distribution for firms

     – Determines distribution of mean/variances across firms

  2. Interest-rate spread, $\mathbf{s}$, and output, $\mathbf{o}$

     – Determines efficiency of financial and non-financial sectors, x and z

- Rest of the World

  – Take U.S. parameter values

  – Use each country's interest-rate spread and output, $\mathbf{s}$, and output, $\mathbf{o}$, to determine their x and z

6.1 How Reasonable is z?

- ln z correlates well the the Beck at al measure of efficiency in the financial sector

Cross-Country Evidence	
	ln z with Beck et al (2000, 2001)
Corr(model, data)	0.81

6.2 Financial Development and Firm Size

- Firms should be larger in countries with better developed financial systems
  - Beck, Demirgüç-Kunt, and Maksimovic (2006)
  - Run regression of firm size on spreads

$$\ln(size) = constant + \eta \times spread + \iota \times controls.$$

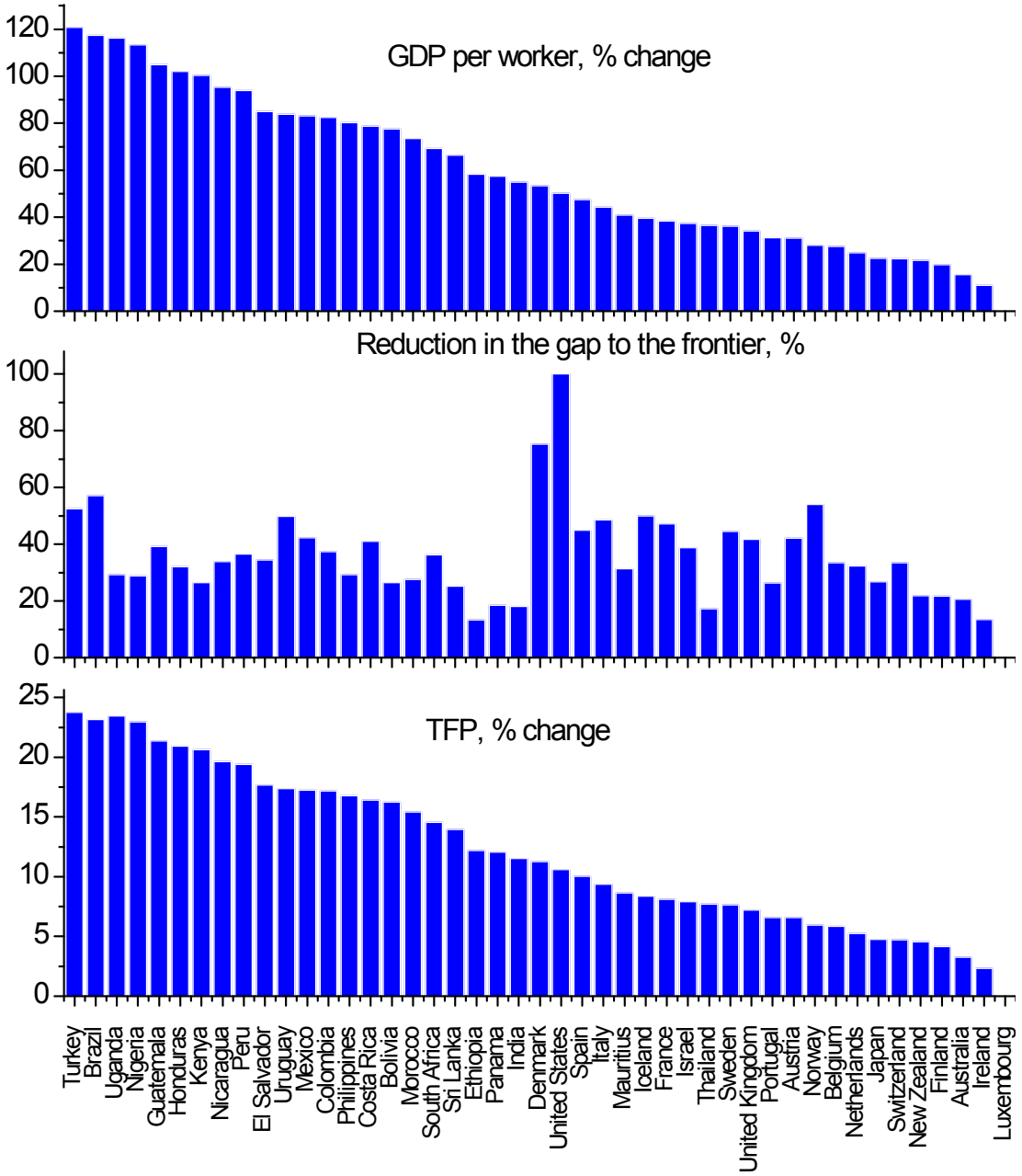
Cross-Country Firm-Size Regressions

	Data	*Model*
Interest-rate spread coefficient, η	-0.16	-0.19
Standard error for η	0.07	0.03
Number of country observations	29	29
R^2	0.51	0.93

- Coefficient on spread
  - Reduce interest rate spread from 10 percentage points to 1 percentage point
  - Go from worst 5 percent of countries to top 5 percent of countries
  - Average size of top 100 firms would rise by 144%
  - Beck et al: If Turkey moved to South Korea then interest-rate spreads output of top 100 firms would double

6.3 How much does Financial Development Matter?

- Best financial practice, $\overline{z} = \max\{z_i\}$
- Best industrial practice, $\overline{x} = \max\{x_i\}$
- Country i's output (per worker), $\mathbf{O}(x_i, z_i)$
- Country i's output with best financial practice, $\mathbf{O}(x_i, \overline{z})$
- Output with best practice in both sectors, $\mathbf{O}(\overline{x}, \overline{z})$
- Gap in output, $\mathbf{O}(\overline{x}, \overline{z}) - \mathbf{O}(x_i, z_i)$


GDP per worker, % change
120
100
80
60
40
20
0
Reduction in the gap to the frontier, %
100
80
60
40
20
0
TFP, % change
25
20
15
10
5
0
Turkey
Brazil
Uganda
Nigeria
Guatemala
Honduras
Kenya
Nicaragua
Peru
El Salvador
Uruguay
Mexico
Colombia
Philippines
Costa Rica
Bolivia
Morocco
South Africa
Sri Lanka
Ethiopia
Panama
India
Denmark
United States
Spain
Italy
Mauritius
Iceland
France
Israel
Thailand
Sweden
United Kingdom
Portugal
Austria
Norway
Belgium
Netherlands
Japan
Switzerland
New Zealand
Finland
Australia
Ireland
Luxembourg

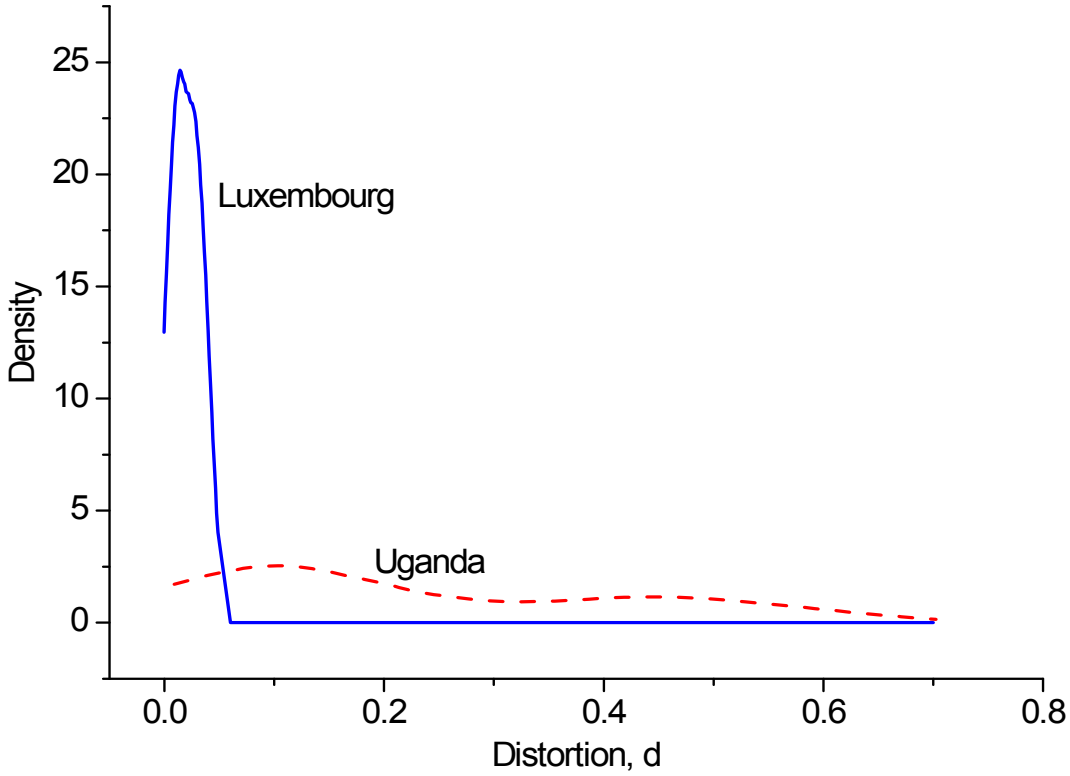
World-Wide Move to Best Financial Practice, $\overline{z}$	
Increase in world output (per worker)	65%
Reduction in output gap	35.6%
Increase in world TFP	17.4%
Fall in dispersion of ln(output)	27.2 perc pts
Fall in mean of distortion	20.8 perc pts
Fall in mean dispersion of distortion	13.5 perc pts

6.4 Idiosyncratic Distortions

- Restuccia and Rogerson (2008)
  - Idiosyncratic distortions across firms can generate large TFP differences (30 to 50 percent)
  - Information frictions put a distortion, d, in investment decision

$$d = \pi_1 r_1 + \pi_2 r_2 - \widetilde{r}$$

  - Mean variance of the distortion are much larger in countries with less developed financial system



The distribution of distortions across establishments for the Luxembourg and Uganda–the model

7 Why Doesn't Technology Flow from Rich to Poor Countries?

- Countries *choose* different production technologies
- Poor countries have technologies with low and stagnant TFPs
  - Small plants
    - little growth over time
    - low costs of production
- Why doesn't technology flow from rich to poor countries?

7.1 Hypothesis

- Efficiency of financial markets plays an important role in the adoption of new technologies

- Focus on:

  1. *Monitoring* – Ability to detect fraud or malfeasance

  2. *Cash flow control* – Ability to redirect funds from beginning to end of project

     – Firm can retain the fraction ψ of *publically acknowledged* output

       * Need to provide incentives so that it won't do this

7.2 Quantitative Analysis

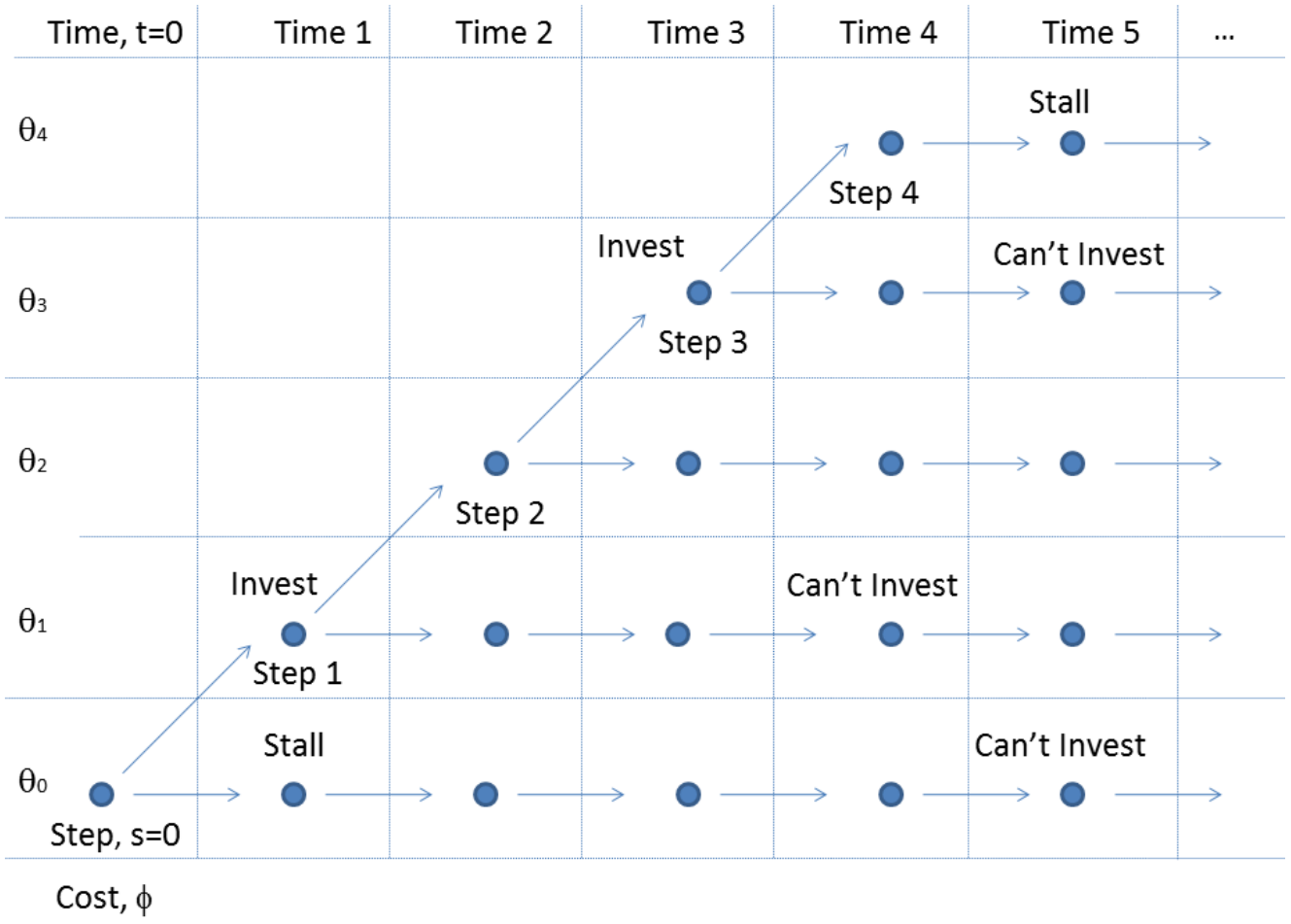
- *Question*: Can the theory account for the differences in the levels of economic development for three countries?
  - India, Mexico and the U.S.

- *Answer*: Yes

8 Identifying Technologies with a Productivity Ladder

- Firms live for T periods.
- Pay fix entry cost ϕ
- Climb a productivity ladder over their life
  - Productivity ladder, $\{\theta_0, \theta_1, ..., \theta_{s-1}, \theta_s, ...\theta_S\}$
  - Can move from step $s-1$ to step s
  - Can invest in working capital at this time

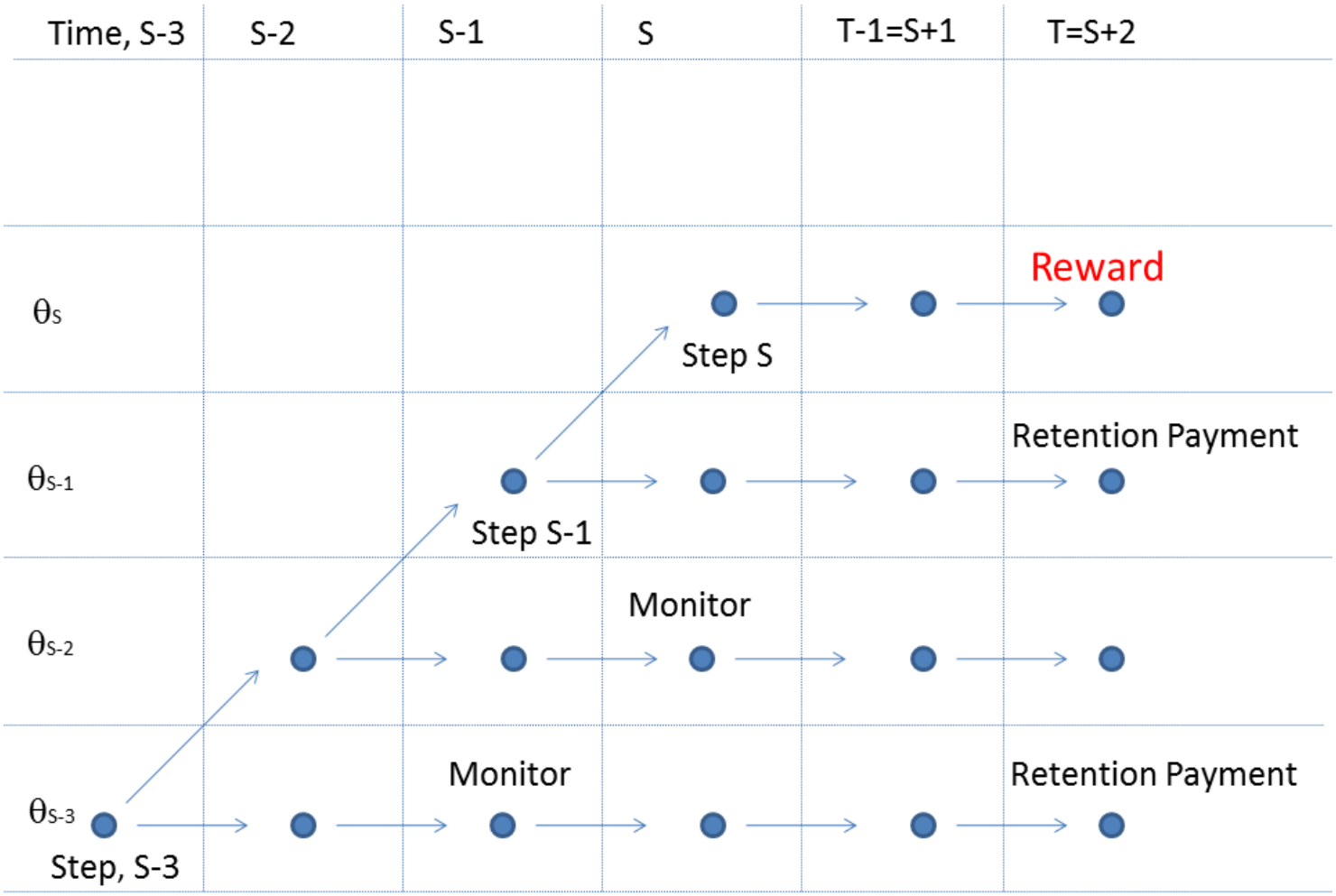
- Move up the ladder with some probability, ρ
- Stall with probability, $1 - \rho$
  - Remain stuck forever after a stall
  - Cannot adjust working capital after stall–irreversibility



Possible productivity paths for a venture over its lifespan

9 The Contract

- Backload all payments to the end of time, T
- Payout a reward upon the successful completion of the project at date/state (S, T)
- Monitor all claims of a stall forever after
- At the end of each stall path need to make a no-retention payment at date/state (s, T)

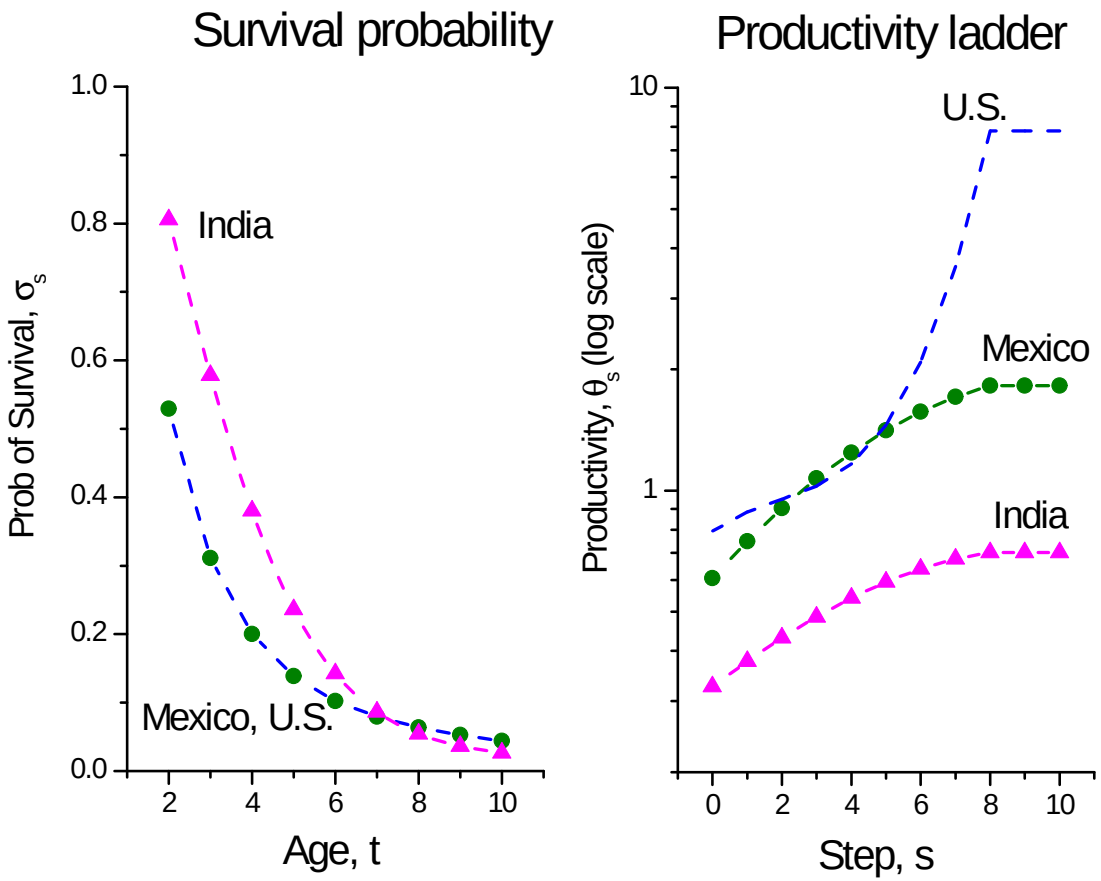


The Contract

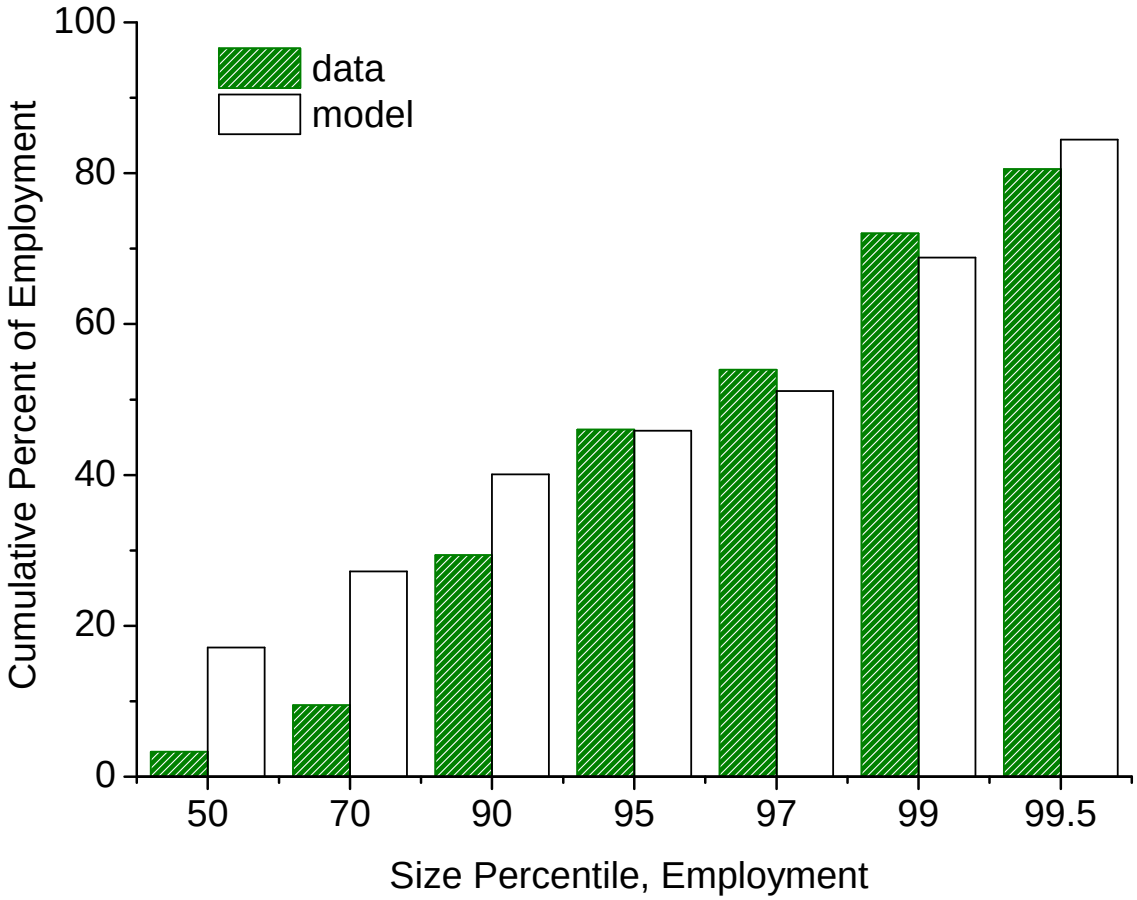
10 Calibration

- Pick technology ladders used in India, Mexico and the U.S to match

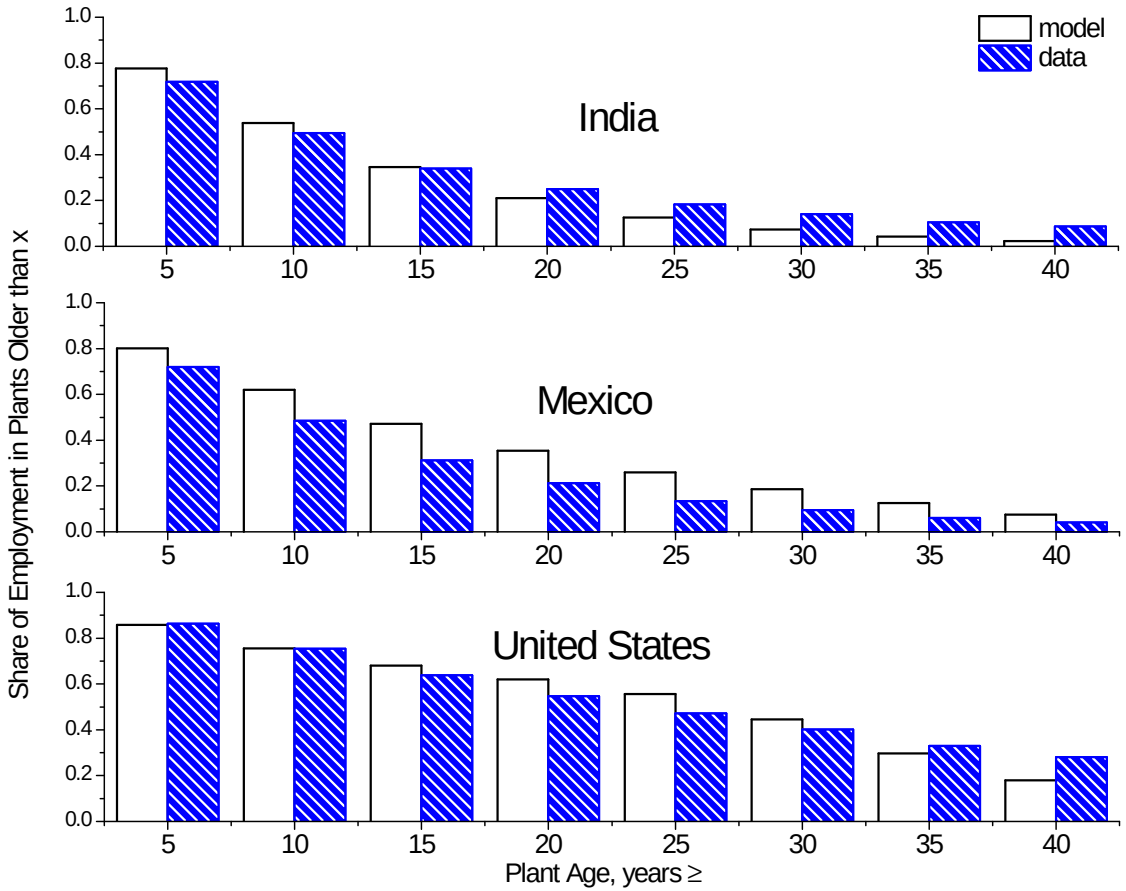
  1. Average Plant Size (relative to U.S.)
  2. Output per Worker (relative to U.S.)
  3. Distribution of employment by age of plant
  4. Financial sector productivity
  5. ln(Old plants TFP / Young plants TFP)
  6. Lorenz curve of the distribution of employment across plants (for U.S. only)



Productivity and survival in India, Mexico, and the U.S.



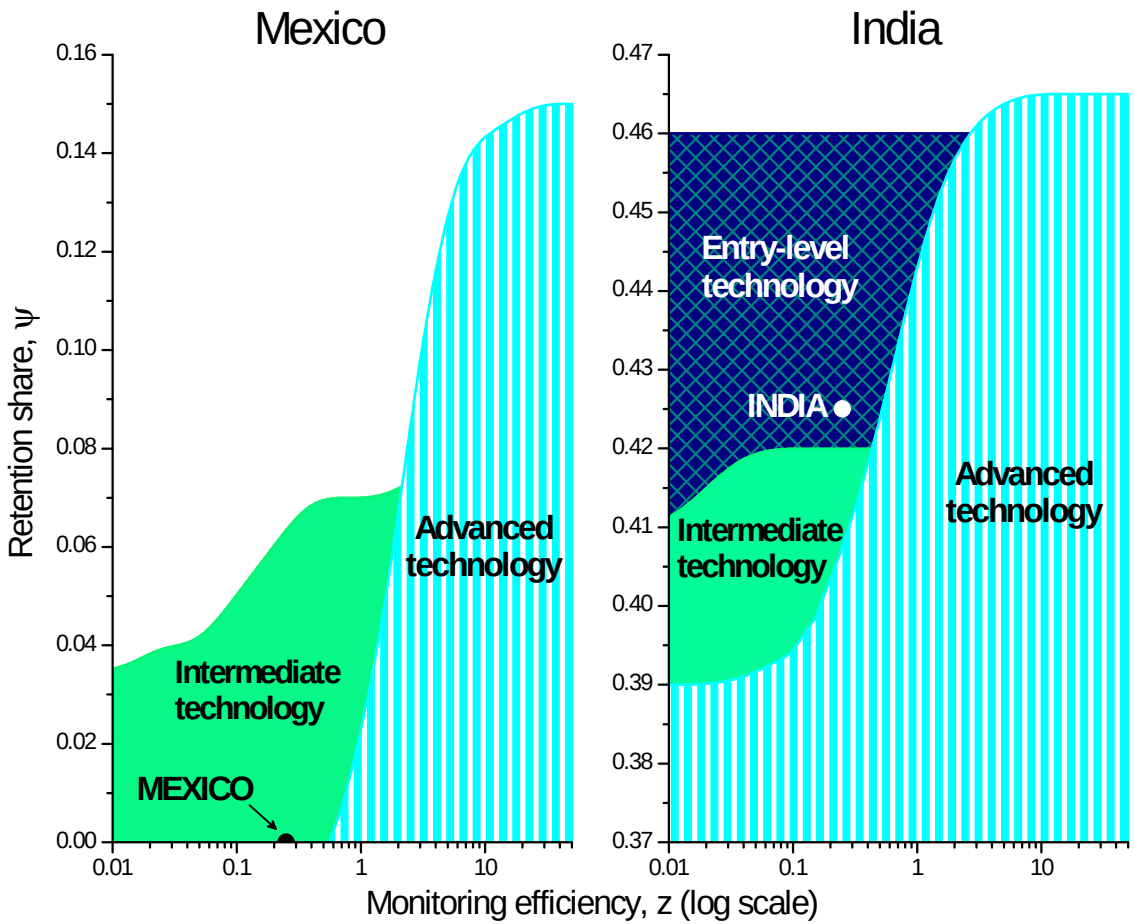
U.S. establishment-size distribution in Lorenz-curve form



The (complementary) cumulative distributions of employment by age ($\geq$)

Facts for India, Mexico, and the U.S.

Statistics	*U.S.*		*Mexico*		*India*	
	Data	Model	Data	Model	Data	Model
Output per worker	1.00	1.00	0.33	0.33	0.12	0.15
TFP	1.00	1.00	0.46	0.46	0.24	0.30
TFP, hum cap adj	1.00	1.00	0.69	0.68	0.49	0.60
Average firm size	1.00	1.00	0.55	0.50	0.11	0.07
Empl share, age $\leq$ 10 yrs	0.25	0.24	0.52	0.38	0.51	0.46
ln(TFP$_{age>35}$)-ln(TFP$_{age<5}$)	2.23	1.91	0.51	0.45	0.30	0.15



The zones of adoption for India (right panel) and Mexico (left panel).

Financial Efficiency and Retention

Variable	*India*	*Mexico*	*U.S.*
Financial Sector Efficiency, z			
z, model	0.25	0.25	25
Getting credit rank	40	40	4
Productivity, deposits	0.37	0.45	1.0
Productivity, deposits–model	0.37	0.49	1.0
Retention, ψ			
ψ, model	0.42	0	0
Recovery rate	20%	67%	82%
Resolving insolvency, yrs	7	1.8	1.5
Enforcing contracts, days	1,420	415	300

11 Conclusions

- Explore the link between financial intermediation and economic development
  - Capital deepening
  - Reallocation of capital across plants
  - Choice of technologies
- Embed a Townsend (1979)-style costly-state-verification paradigm into versions of the standard growth model
- Use facts on establishment-size distributions to identify differences in productivities/technologies across firms

- Differences in financial development are important across countries
  - Move to best practice
    - World TFP would increase by 18 to 33 percent
    - World output would increase by 65 to 88 percent

- Differences in technological adoption due to differences in financial structure can potentially explain:
  1. Differences in incomes across India, Mexico and the U.S.
  2. Differences in TFPs across India, Mexico and the U.S.

References

[1] Cole, Harold L., Greenwood, Jeremy and Sanchez, Juan M. "Why Doesn't Technology Flow from Rich to Poor to Countries?" Unpublished paper, Department of Economics, University of Pennsylvania, 2012.

[2] Greenwood, Jeremy, Sanchez, Juan M. and Wang, Cheng (forthcoming). "Quantifying the Impact of Financial Development on Economic Development." *Review of Economic Dynamics*. (Special issue on "Misallocation and Productivity," edited by Diego Restuccia and Richard Rogerson.)