Quantifying the Impact of Financial Development on Economic Development

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Lecture Notes

1 Introduction

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

- Illustrated by the cross-country relationship between
  - interest-rate spreads
  - capital-to-output ratios and TFPs

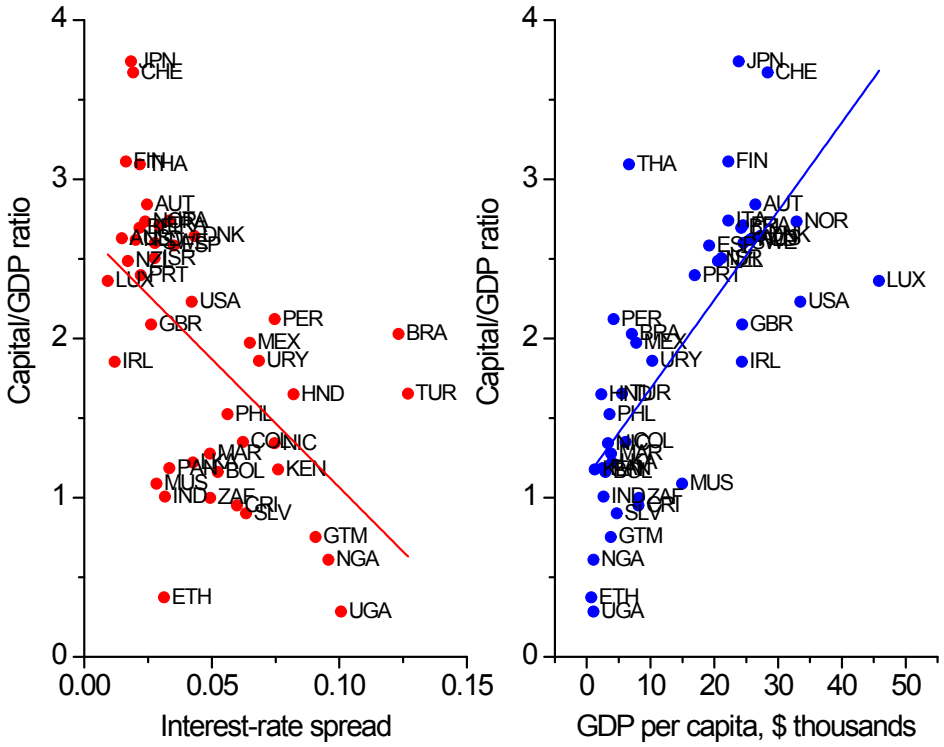


Figure 1: Capital Deepening

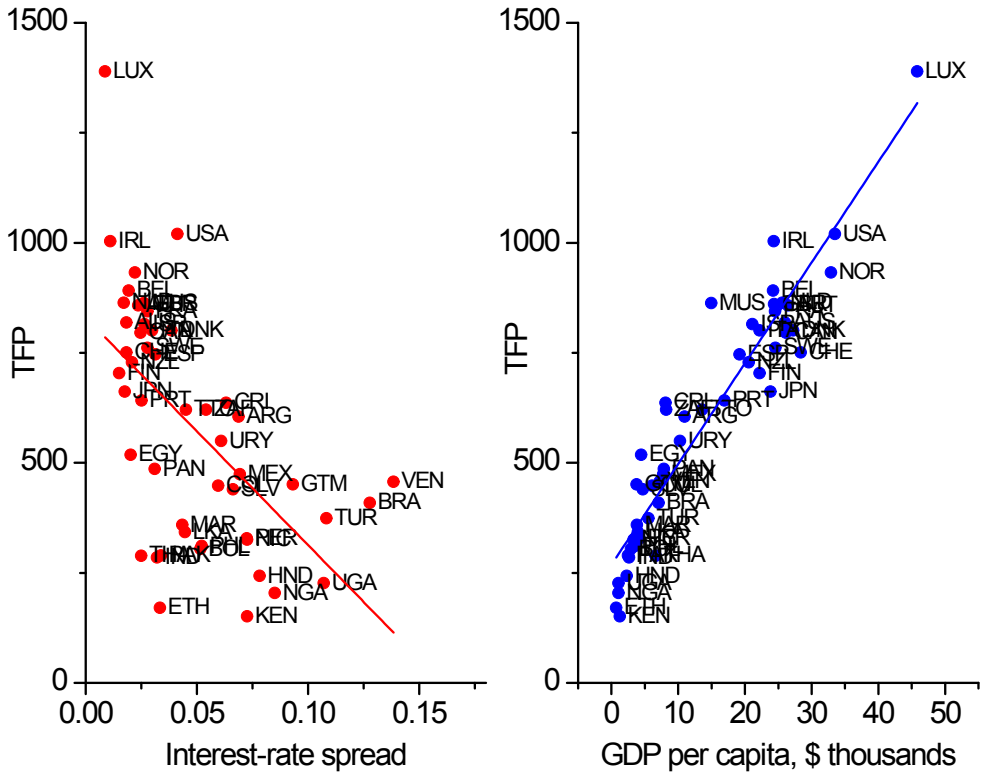
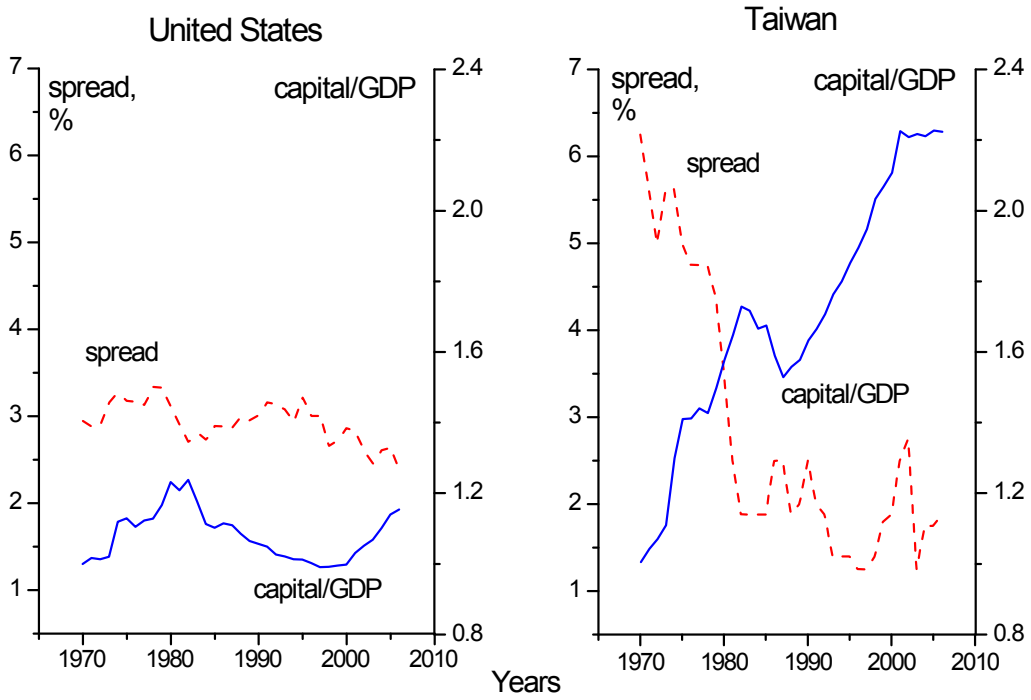


Figure 2: Reallocation

1.1 U.S. and Taiwan



Interest-Rate Spreads and Capital/Output Ratios

1.2 Theory

- Costly State Verification Model a la Townsend (1979) and Williamson (1986)

- 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

- Financial theory of firm size emerges

- Technological progress in the financial sector leads to capital *deepening* and *reallocation*
  - Balanced growth
  - Unbalanced growth

1.2.1 Four ingredients:

1. *Output is produced by firms using capital and labor*.

   (a) Capital must be raised externally.

   (b) Distribution of idiosyncratic returns for each firm.

      - Realized state is private information.

   (c) There is a distribution over firms of these distributions in returns.

2. *Production is governed by constant returns to scale*.

   (a) No informational frictions.

      i. No rents will be earned.

      ii. Only projects with the highest expected return will be funded.

   (b) With informational frictions.

      i. Inefficient projects are funded.

      ii. Rents are earned.

3. *Competitive intermediation.*

   (a) Lending contracts between intermediaries and firms.

      - Value of firms maximized–intermediaries earn zero profits.

   (b) Intermediaries monitor firms.

      - Costly state verification model.

      - Degree of vigilance is flexible.

        – Loan size is determinate.

        – Simple threshold rule for funding.

        – Funding increasing in expected return, decreasing in variance.

4. *Technological improvement in the monitoring technology*.

   (a) Intermediation becomes more efficient.

   (b) Rents are squeezed.

   (c) Funds redirected toward more efficient firms.

1.3 Quantitative Analysis

- Model calibrated to U.S. data
  - Firm-size distribution, output, interest-rate spreads
- U.S. and Taiwan
  - 30% of U.S. growth
  - 45% of Taiwanese growth

- Cross-Country Analysis–45 countries
  - Uganda
    - financial best practice could raise output by 116% and TFP by 23%
  - World
    - financial best practice could raise output by 53%
  - Bulk of variation in world output (69%) is *not* explained by financial factors

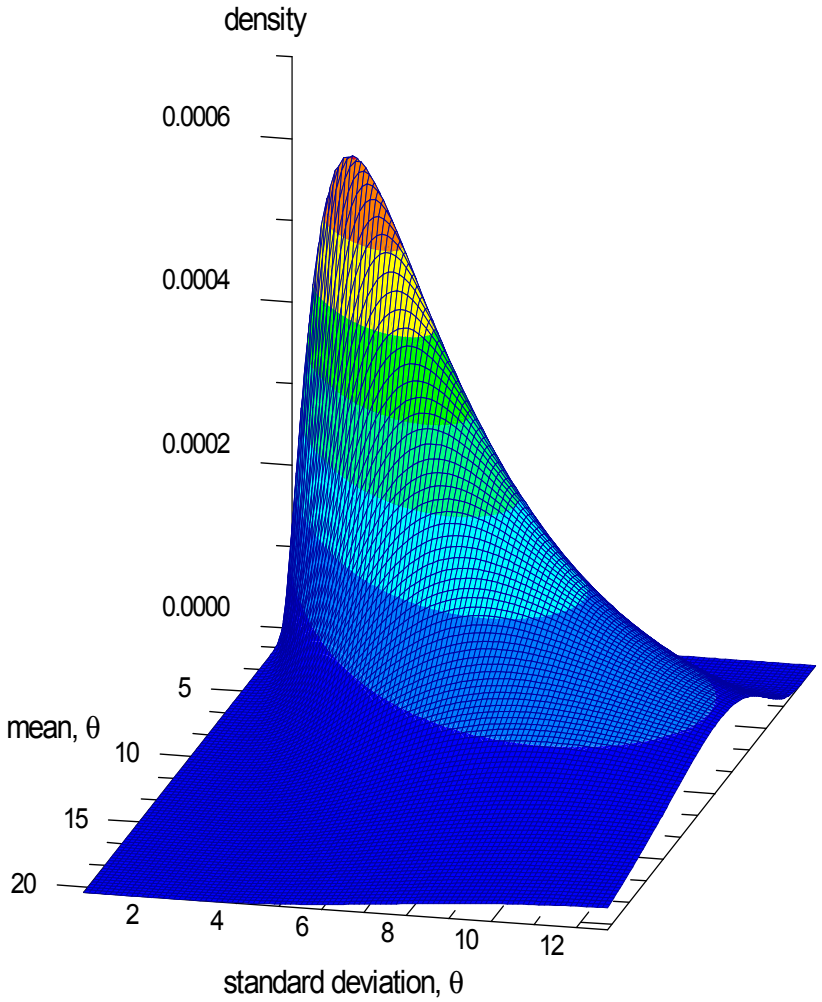
2 Firms

- 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

3 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.
- m_j, resources devoted to monitoring a claim of state j.

3.1 Monitoring Technology

- $P_{ij}(m_j/k)$, 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 m_j/k.
  -

$$\underbrace{1 - P_{ij}(m_j/k)}_{\text{Odds not caught}} = (\epsilon m_j/k)^{-\psi}, \text{ with } 0 < \psi < 1.$$

- $C(m/z; w)$, cost function associated with monitoring

$$C(m/z; w) = w(m/z)^{\gamma}, \text{ with } \gamma > 1.$$

  - w, wage rate for labor.
  - z, productivity.

4 Contracting Problem

4.1 Notation

- v, outside value of the firm.

- $\widetilde{r}$, cost of capital for the intermediary.

  – return to savers plus capital consumption.

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

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

4.2 Intermediary's Problem

$$I(\tau, v) \equiv \max_{\substack{p_1,p_2,p_{12},p_{21},\\ m_1,m_2,k}} \underbrace{\{\pi_1 p_1 + \pi_2 p_2 - \widetilde{r}k - \pi_1 w(m_1/z)^{\gamma} - \pi_2 w(m_2/z)^{\gamma}\}}_{\text{Intermediary's profits}},$$

subject to

$$p_1 \leq r_1 k, \quad p_2 \leq r_2 k, \quad \underbrace{p_{12} \leq r_1 k}_{\text{caught cheating}}, \quad \underbrace{p_{21} \leq r_2 k}_{\text{caught cheating}}, \qquad \text{(limited liability)}$$

$$\overbrace{\underbrace{[1 - P_{21}(m_1/k)](r_2 k - p_1)}_{\text{not caught}} + \underbrace{P_{21}(m_1/k)(r_2 k - p_{21})}_{\text{caught}}}^{\text{misrepresent}} \leq \overbrace{r_2 k - p_2}^{\text{tell truth}},$$

(incentive constraint – good state, 2)

$$\pi_1(r_1 k - p_1) + \pi_2(r_2 k - p_2) = v. \qquad \text{(promise keeping)}$$

4.3 The Contract

1. *Payment schedule*

   (a) take everything upon report of bad state or when caught cheating

   $$p_1 = r_1 k \qquad \text{(not caught cheating)},$$

   $$p_{21} = r_2 k \qquad \text{(caught cheating)}.$$

   (b) payment in good state yields expected return of v

   $$p_2 = r_2 k - v/\pi_2.$$

   - I.e.,

   $$\underbrace{\pi_2(r_2 k - p_2)}_{\text{expected rents, good state}} = \underbrace{v}_{\text{outside option}}.$$

2. *Loan size*, k

$$\underbrace{\pi_2(r_2 - r_1)[1 - P_{21}(m_1/k)] \times k}_{\text{value of cheating = value of telling truth}} = \underbrace{v}_{\text{outside option}} .$$

3. *Monitoring* – only in bad state

$$I(\tau, v) \equiv \max_{m_1/k} \{\underbrace{(\pi_1 r_1 + \pi_2 r_2 - \widetilde{r})k}_{\text{net return on capital}} - \underbrace{\frac{\pi_1 w}{z^\gamma} k^\gamma (\frac{m_1}{k})^\gamma}_{\text{monitoring cost}} - \underbrace{v}_{\text{payment to firm}} \},$$

where k is given above.

5 Competitive Intermediation

- Perfect competition among intermediaries
  - Contract maximizes value of the firm, v.
  - Intermediary makes zero profits, for each type of loan τ.
- Intermediary's profit function is $\cap$-shaped in v.
- Threshold rule for project funding

$$\underbrace{\mathcal{A}(w)}_{\text{set of funded projects}} = \{\tau : \underbrace{\pi_1 r_1 + \pi_2 r_2}_{\text{expected return}} - \widetilde{r} > 0\} \text{ or } \{\tau : w < \underbrace{\overline{W}(\tau)}_{\text{threshold wage}}\}.$$

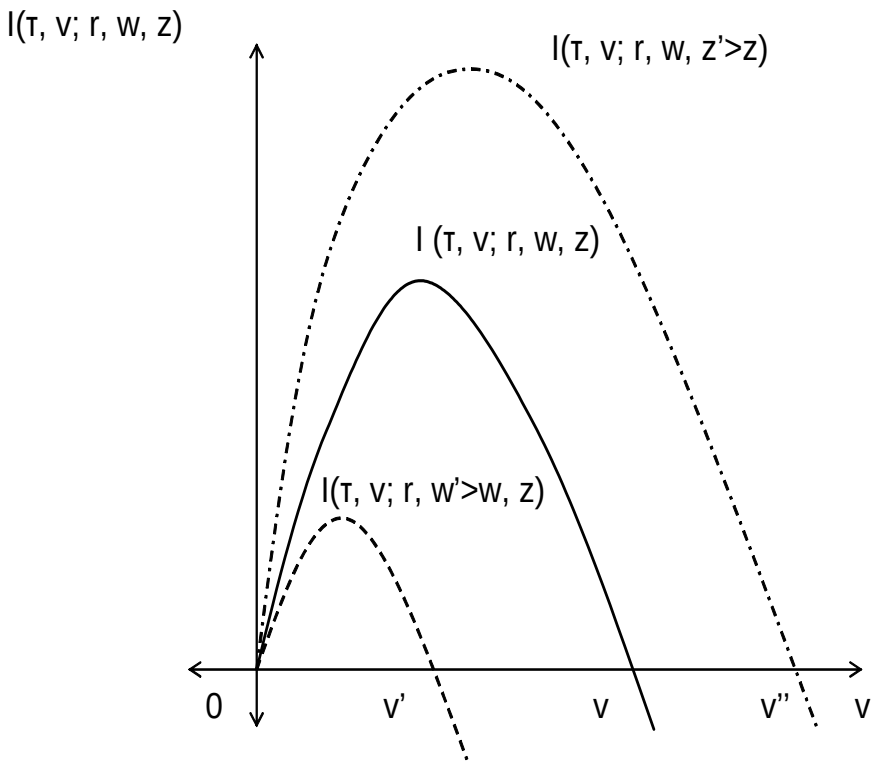


Figure 3: The profit function, $I(\tau, v)$. Also shows the mpact of an increase in w and z on profits

6 Technological Progress

Examine two special cases:

(i) balanced growth,

(ii) efficient finance.

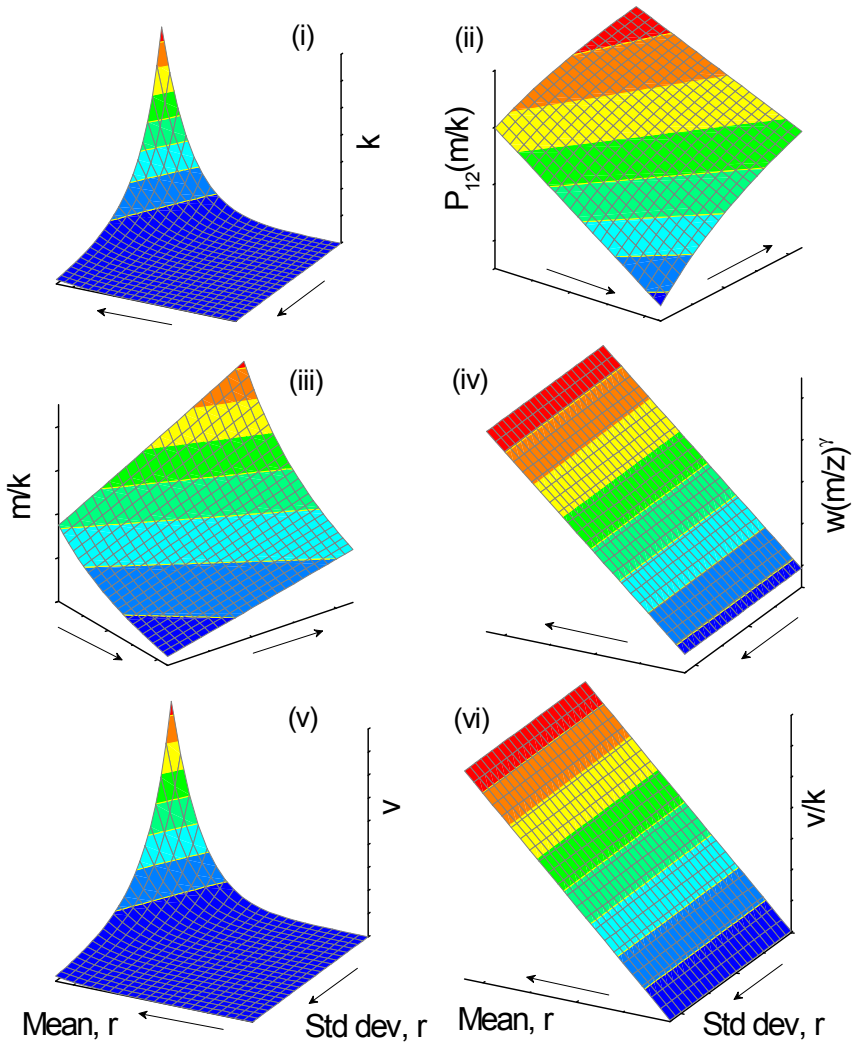


Figure 4: Determination of Firm Size

6.1 Balanced Growth

- θ_i's grow at the common rate g.

- z grows at rate $g^{1/(1-\alpha)}$.

Proposition. *(Balanced Growth). Along a balanced growth path:*

(i) The capital stock, k, wages, w, and rents, v, will grow at rate $g^{1/(1-\alpha)}$;

(ii) The active set shifts northeast [in (θ_1, θ_2)-space] at rate g;

(iii) Monitoring per unit of capital, m_1/k, will remain constant.

Proposition. *(Technological progress in financial intermediation). Take two z's with*

$$z < z'.$$

Then:

(i)

$$A(w') \sqsubset \mathcal{A}(w),$$

where $w = W(z) < w' = W(z')$.

(ii) Consider τ *and* τ' *such that*

$$\tau = (\theta_1, \theta_2) \in \underbrace{\mathcal{A}(w) - \mathcal{A}(w')}_{\text{set of cut projects}} \text{ and } \tau' = (\theta_1', \theta_2') \in \underbrace{\mathcal{A}(w')}_{\text{retained projects}}.$$

It follows that

$$\pi_1(\theta_1)^{1/\alpha} + \pi_2(\theta_2)^{1/\alpha} < \pi_1(\theta_1')^{1/\alpha} + \pi_2(\theta_2')^{1/\alpha}.$$

Proposition. *(Efficient finance). Let* $z \to \infty$. *Then,*

1. $\lim_{z\to\infty} m_1/k = \infty$ *and* $\lim_{z\to\infty} P_{21}(m_i/k) = 1$,

2. $\lim_{z\to\infty} p_2 = r_2 k$ *and* $\lim_{z\to\infty} v = 0$,

3. $\lim_{z\to\infty} \mathcal{A}(w) = \mathcal{A}^* \equiv \underset{\tau=(\theta_1,\theta_2)\in\mathcal{T}}{\arg\max}[\ \pi_1(\theta_1)^{1/\alpha} + \pi_2(\theta_2)^{1/\alpha}]$,

4. $\lim_{z\to\infty} \int_{\mathcal{A}(w)} k dF = k^*$ *(k^*, capital stock in the neoclassical growth.)*

7 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. Establishments size distribution for firms
  2. Interest-rate spread, $\mathbf{s}$, and output, $\mathbf{o}$

7.1 Minimization Routine

$p = (\epsilon, \psi, \gamma, \sigma^2_{\theta_1}, \sigma^2_{\theta_2}, \rho)$, parameter vector.

$\mu_{\theta i} = E[\ln \theta_i]$, $\sigma^2_{\theta_i} = E[\ln \theta_i^2] - E[\ln \theta_i]^2$

$\rho =$ correlation between $\ln(\theta_1)$ and $\ln(\theta_2)$

$$\min_p \underbrace{\left\{ \sum_{j=1}^{7} \frac{w_j}{2} [\overbrace{e^{US}_{j,74}}^{\text{Data}} - \overbrace{M_j\left(x^{US}_{74}, z^{US}_{74}, p\right)}^{\text{Model}}]^2 + \sum_j \frac{w_j}{2} [e^{US}_{j,04} - M_j\left(x^{US}_{04}, z^{US}_{04}, p\right)]^2 \right\}}_{\text{Firm-Size Distribution–deviations, data and model}},$$

subject to

- Match observed output and interest-rate spreads

$$(\mathbf{o}_{74}^{US}, \mathbf{s}_{74}^{US}) = O(x_{74}^{US}, z_{74}^{US}; p),$$

and

$$(\mathbf{o}_{04}^{US}, \mathbf{s}_{04}^{US}) = O(x_{04}^{US}, z_{04}^{US}; p).$$

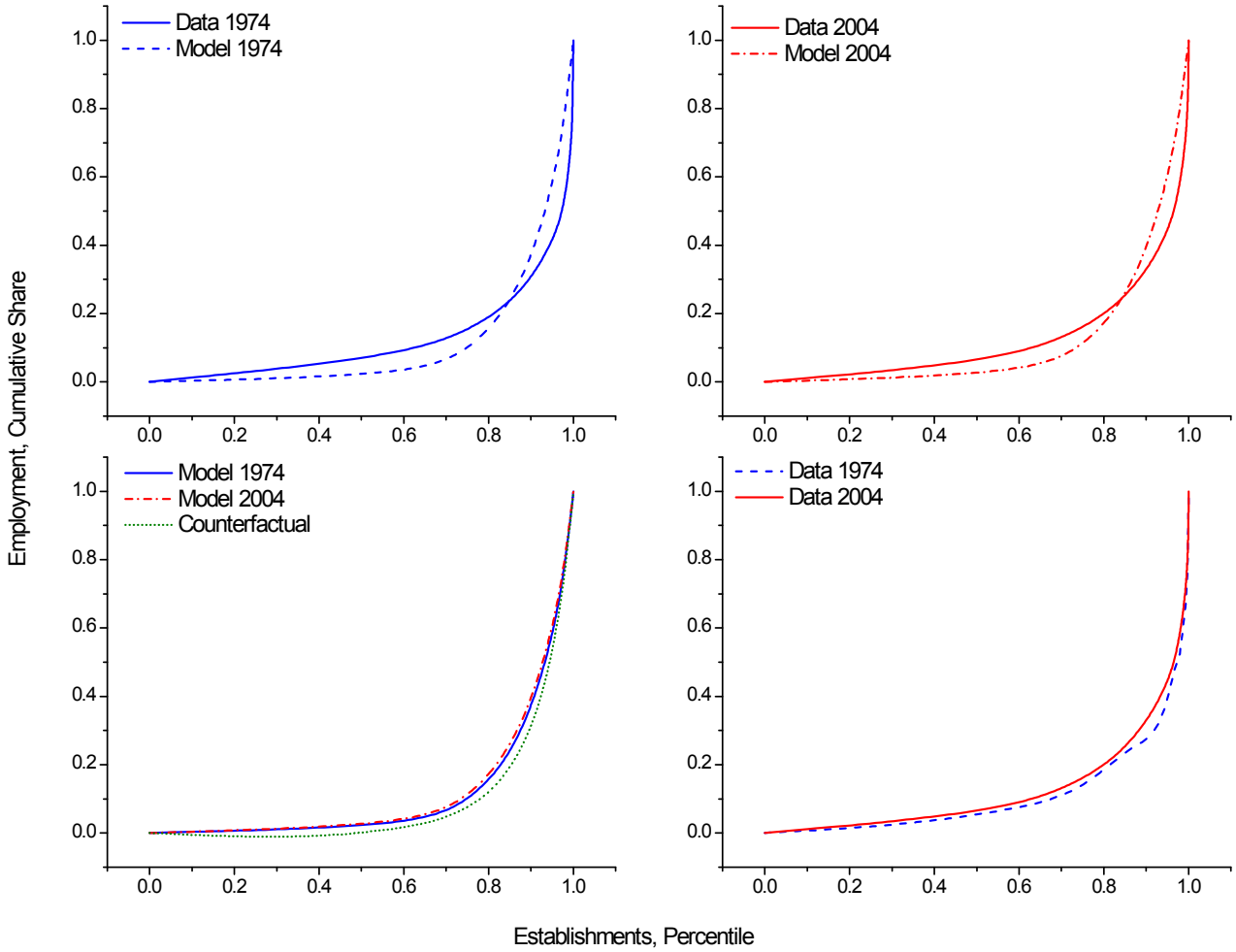


Figure 5: Establishments

8 U.S. and Taiwan

8.1 U.S.–Balanced Growth

- Balanced Growth between 1974 and 2004
  - Firm-size distribution, small change.
  - Interest-rate spread, modest decline.
  - Capital/output ratio, small increase.

- Technological Improvement in the financial sector
  - Model, 2.6 percent a year
  - Data, 2.2 percent a year (Berger, 2003)
  - Contribution to growth, 1/3
    - Economy in 2004 with z_{1974}

The U.S. Economy

	Data	*Model*
1974		
Spread, $\mathbf{s}$	3.07%	3.07%
GDP (per capita), $\mathbf{o}$	\$22,352	\$22,352
capital-to-output ratio (indexed), $\mathbf{k/o}$	1.00	1.00
TFP		6.17
2004		
Spread, $\mathbf{s}$	2.62%	2.62%
GDP (per capita), $\mathbf{o}$	\$41,208	\$41,208
capital-to-output ratio (indexed), $\mathbf{k/o}$	1.02	1.09
TFP		8.92
2004 Counterfactual, $z^{US}_{2004} = z^{US}_{1974}$		
Spread, $\mathbf{s}$	2.62	3.93
GDP (per capita), $\mathbf{o}$	\$41,208	\$34,530
capital-to-output ratio (indexed), $\mathbf{k/o}$	1.02	0.87
TFP		8.59
Yearly growth in financial productivity		2.58%

8.2 Taiwan–Unbalanced Growth

- Unbalanced growth between 1974 and 2004
  - Interest-rate spread, large drop
  - Capital/output ratio, large increase
- Technological Improvement in the financial sector
  - Model, 10% a year
  - Contribution to growth, 45%

The Taiwan Economy

	Data	*Model*
1974		
Spread, $\mathbf{s}$	5.41%	5.41%
GDP (per capita), $\mathbf{o}$	\$2,211	\$2,211
capital-to-output(indexed), $\mathbf{k/o}$	1.00	1.00
TFP		1.55
2004		
Spread, $\mathbf{s}$	1.96%	1.96%
GDP (per capita), $\mathbf{o}$	\$13,924	\$13,924
capital-to-output(indexed), $\mathbf{k/o}$	1.847	1.76
TFP		4.20
2004 Counterfactual, $z^T_{2004} = z^T_{1974}$		
Spread, $\mathbf{s}$	1.96%	10.43%
GDP (per capita), $\mathbf{o}$	\$13,924	\$6,176
capital-to-output(indexed), $\mathbf{k/o}$	1.847	0.62
TFP		3.57
Yearly growth in financial productivity		9.90%

9 Cross-Country Analysis

- Take model calibrated to the U.S. economy.

- Make an inference about x and z given an observation on $\mathbf{o}$ and $\mathbf{s}$, using

$$(x, z) = O^{-1}(\mathbf{o}, \mathbf{s}).$$

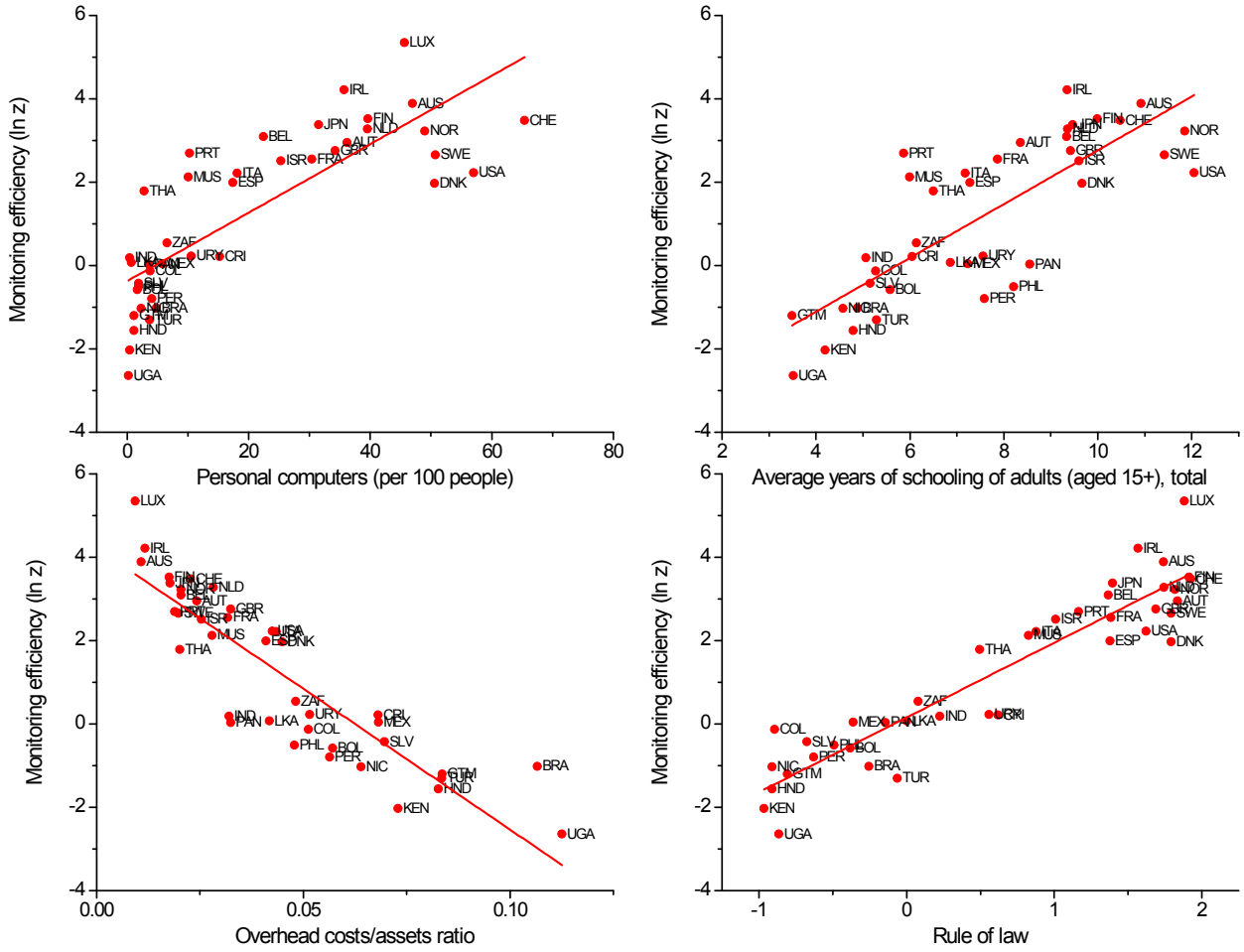
- Do this for a sample of 45 countries.

9.1 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)	0.80

- ln z correlates well with measures of IT use, overhead costs, human capital and rule of law


Monitoring efficiency (ln z)
Personal computers (per 100 people)
Monitoring efficiency (ln z)
Average years of schooling of adults (aged 15+), total
Monitoring efficiency (ln z)
Overhead costs/assets ratio
Monitoring efficiency (ln z)
Rule of law

9.2 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	-22.4	-16.6
Standard error for η	2.35	6.55
Number of country observations	27	27
R^2	0.80	0.54

- 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 154%
  - Beck et al: If Turkey moved to South Korea then interest-rate spreads output of top 100 firms would double

9.3 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

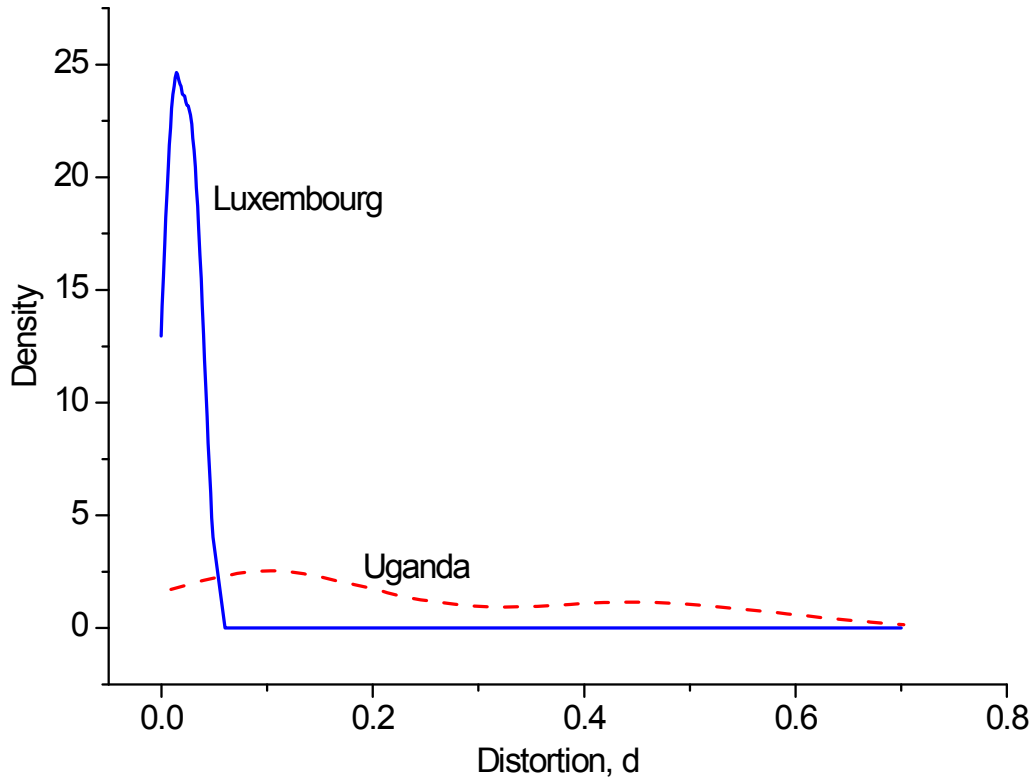


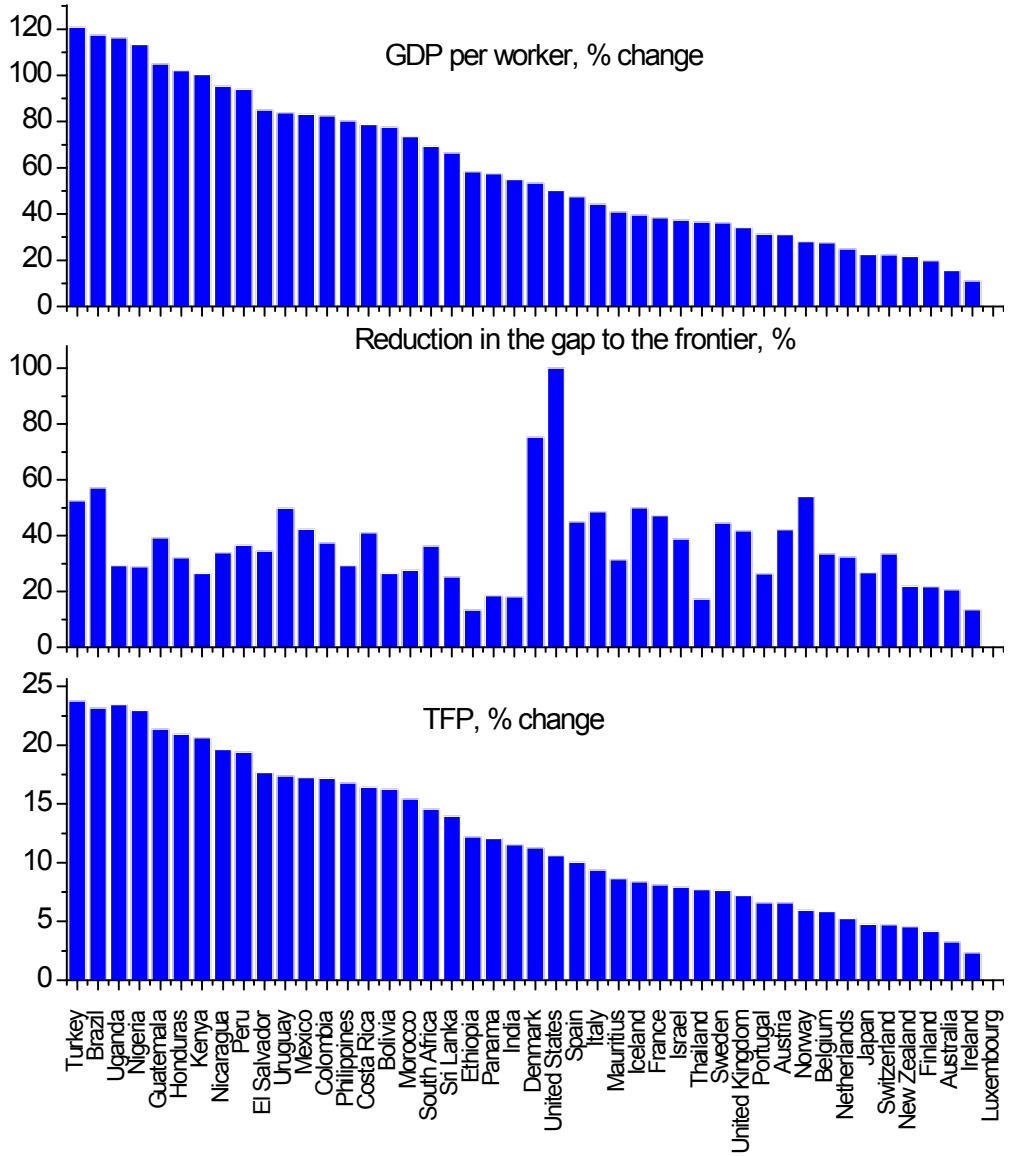
Figure 6: The distribution of distortions across establishments for the Luxembourg and Uganda–the model

9.4 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, $\mathbf{O}(\overline{x}, \overline{z}) - \mathbf{O}(x_i, z_i)$.

World-Wide Move to Best Financial Practice, $\overline{z}$

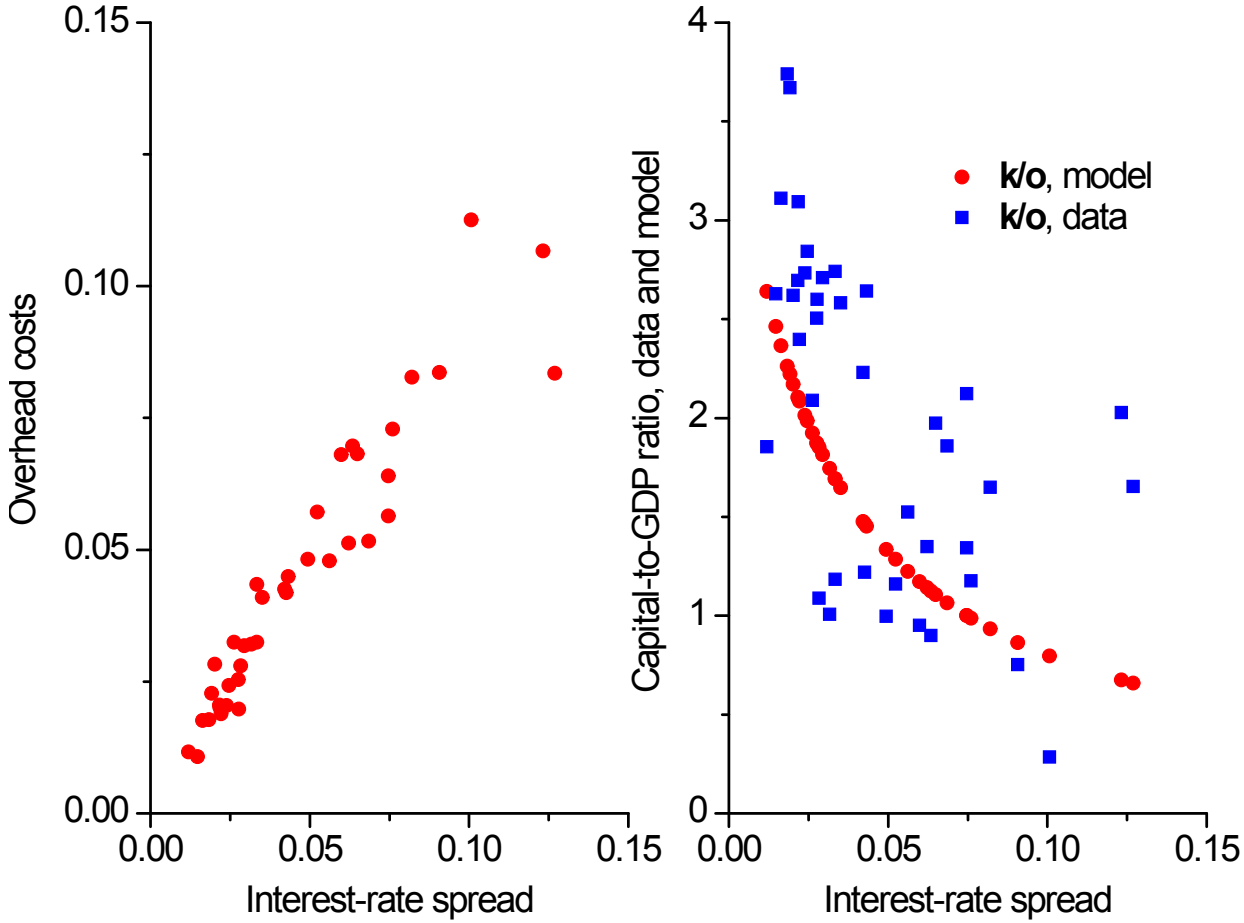
Increase in world output (per worker)	53.3%
Reduction in output gap	30.8%
Increase in world TFP	13.5%
Fall in dispersion of ln(output)	22.8 perc pts
Fall in mean of distortion	14.7 perc pts
Fall in mean dispersion of distortion	9.5 perc pts


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

9.5 Robustness Analysis–Alternative Matching Strategies

World-Wide Move to Best Financial Practice, $\overline{z}$

	Matching Methodology		
	$\mathbf{s}$	$\mathbf{k/o}$	ϕ
Increase in world output	53.2%	48.2%	52.1%
Reduction in output gap	30.8%	25.6%	37.0%
Increase in world TFP	13.5%	14.3%	13.1%
Fall in dispersion of ln(output)	22.8 perc pts	32.8 perc pts	13.8 perc pts


0.15
0.10
0.05
0.00
Overhead costs
0.00
0.05
0.10
0.15
Interest-rate spread
4
3
2
1
0
Capital-to-GDP ratio, data and model
k/o, model
k/o, data
0.00
0.05
0.10
0.15
Interest-rate spread

10 Conclusions

- Explore the link between financial intermediation and economic development
- Embed a costly-state-verification paradigm into the standard growth model
- Firm-size distribution depends on financial development
- Balanced growth path
  - Interest-rate spread, capital-to-output, and firm size constant

- Unbalanced growth
  - Rents get squeezed
  - Interest-rate spreads narrow
  - Reallocation of funds toward the most profitable firms
  - Capital/output ratios and TFP rise
- Mechanism has quantitative significance
  - Relationship between firm size and financial development is similar in the model and data
  - Wedges created by financial frictions resemble idiosyncratic distortions in Restuccia and Rogerson (2008)

- Improvements in intermediation are important for growth in the US and Taiwan

- Differences in financial development are important across countries
  - Move to best practice
    * Uganda–financial best practice could raise output by 116% and TFP by 23%
    * Ireland–financial best practive could rise output by 11% and TFP by 2%
    * World TFP would increase by 13.5%
    * World output would increase by 53%