Finance and Misallocation: Evidence from Plant-Level Data

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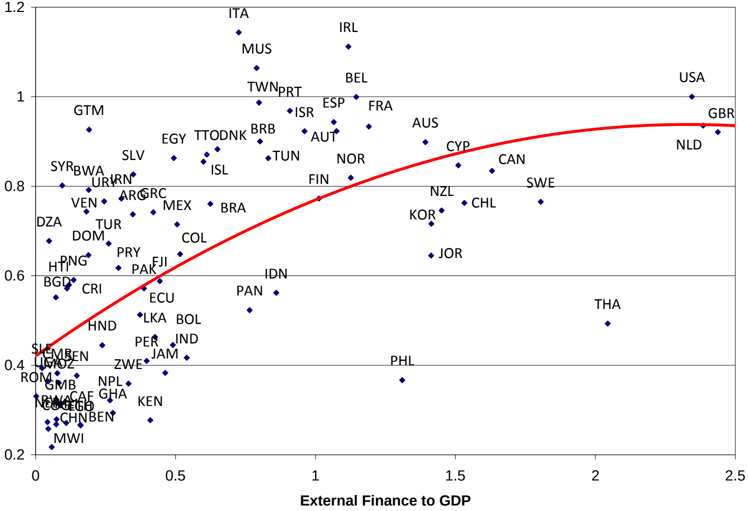
Motivation

- Two observations
  - Strong cross-country correlation Finance and TFP
  - Strong correlation TFP and dispersion plant-level Y/K
- One interpretation:

  finance frictions $\rightarrow$ misallocation $\rightarrow$ lower TFP

Finance vs. TFP



Our goal

- Quantitatively evaluate mechanism
- Plant-level data
  - Korea, Colombia
- Model of establishment dynamics with borrowing constraints

Outline

- 2 channels through which finance distorts allocations:
  - adjustment cost: K, L cannot respond to shocks over time
    - Economy with no exit and entry
  - distort entry and constrain entering entrepreneurs
    - Economy with exit/entry and occupation choice

Our findings

- Adjustment cost channel weak
  - 5 - 6 % TFP losses (1/10th data)
  - not much time-series variability productivity
- Constraints on entering entrepreneurs potentially larger
  - Up to 20-30% TFP losses
  - But data suggests young establishments not constrained
    - Do not grow much faster, have Y/K similar to old
  - Model consistent with these facts predicts 7-10% losses

Model without exit-entry

- Measure 1 workers supply labor inelastically
- Continuum of entrepreneurs
- Efficiency varies time/entrepreneurs
- Plant only source of income. Risk not diversifiable

- Finance (Evans-Jovanovic (1989), Buera-Kaboski-Shin (2009)):
  - save risk-free asset, r
  - must pay L and K in advance
  - can borrow subject to collateral constraint

Technology

- Production function:

$$Y_{it} = E_{it}^{1-\eta} \left(L_{it}^{\alpha} K_{it}^{1-\alpha} \right)^{\eta}$$

- $\eta < 1$
- Efficiency follow Markov process: $\Phi(E_{it+1} | E_{it})$

Problem of entrepreneur

$$\sum_{t=0}^{\infty} \beta^t \frac{C_{it}^{1-\gamma}}{1-\gamma}$$

- B_{it}: beginning-of-period assets (net worth)
- Borrow $WL_{it} + K_{it} - B_{it}$
  - collateral constraint: $WL_{it} + K_{it} - B_{it} \leq (\lambda - 1) B_{it}$

$$C_{it} + B_{it+1} = Y_{it} + (1-\delta) K_{it} - (1+r) [WL_{it} + K_{it} - B_{it}]$$

Problem of entrepreneur

Reduces to

$$\max \sum_{t=0}^{\infty} \beta^t \frac{C_{it}^{1-\gamma}}{1-\gamma}$$

s.t.

$$C_{it} = (1+r) B_{it} + \pi (B_{it}, E_{it}) - B_{it+1}$$

where

$$\Pi (B_{it}, E_{it}) = \max_{K_{it}, L_{it}} E_{it}^{1-\eta} \left(L_{it}^{\alpha} K_{it}^{1-\alpha} \right)^{\eta} - (1+r) W_t L_{it} - (r+\delta) K_{it}$$

$$\text{s.t.} \quad W L_{it} + K_{it} \leq \lambda B_{it}$$

Solution to static problem

- Homogeneity: $b = B/E$, $k = K/E$, $\pi = \Pi/E$

$$\pi\left(b\right) = \max_{k,l} \left(l^{\alpha} k^{1-\alpha}\right)^{\eta} - \left(1+r\right) Wl - \left(r+\delta\right) k$$
$$\text{s.t.} \quad Wl + k \leq \lambda b$$

- Solution:

$$\begin{aligned} F_L\left(L,K\right) &= 1+\tilde{r}(b) \\ F_K\left(L,K\right) &= \tilde{r}(b)+\delta \end{aligned}$$

- $\tilde{r} = r + \mu(b)$: effective cost of funds

Dynamic program

$$V(b,e) = \max_c \frac{c^{1-\gamma}}{1-\gamma} + \beta \int \exp(e'-e)^{1-\gamma} V(b',e')\, d\Phi(e'|e)$$

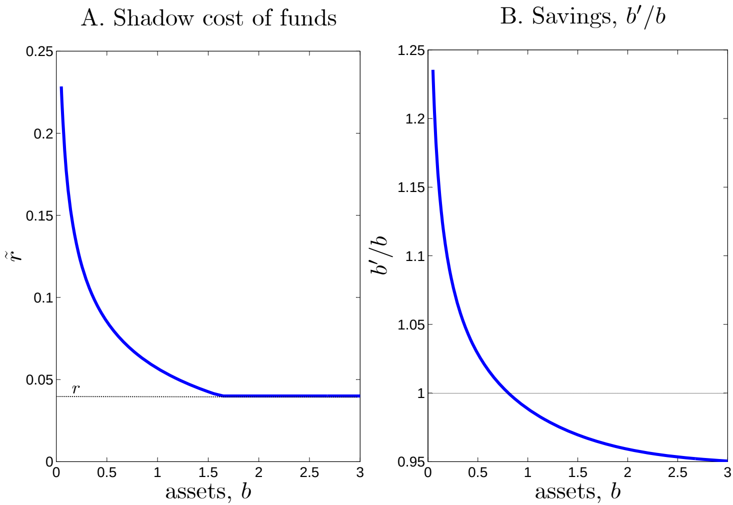
where

$$b' = \frac{(1+r)\,b + \pi(b) - c}{\exp(e'-e)}$$

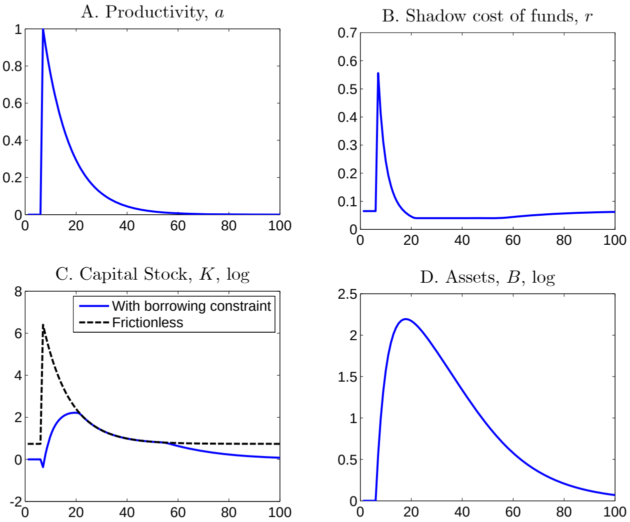
- Solution:

$$c^{-\gamma} = \beta \int (1+r+\lambda\mu') \exp(e'-e)^{-\gamma} c'^{-\gamma} d\Phi(e'|e)$$

Decision rules ($e' = e$)



Response to productivity shock



Summarize

- Absent Δe, ergodic distribution b is degenerate
  - $\tilde{r}$ equal across entrepreneurs
  - No misallocation across establishments
  - Banerjee-Moll '09
- Misallocation requires large dispersion b: large changes e

TFP losses due to misallocation

- Efficient allocations:

$$\max_{K_i, L_i} Y = \int_0^1 E_i^{1-\eta} \left(L_i^{\alpha} K_i^{1-\alpha} \right)^{\eta} di$$

$$\text{s.t.} \int_0^1 K_i di = K, \quad \int_0^1 L_i di = L$$

- Solution:

$$L_i = \frac{E_i}{\int_0^1 E_i di} L, \qquad K_i = \frac{E_i}{\int_0^1 E_i di} K$$

$$Y = E^{1-\eta} \left(L^{\alpha} K^{1-\alpha} \right)^{\eta}, \qquad E = \int_0^1 E_i di$$

TFP losses due to misallocation

- Allocations with frictions:

$$L_i = \omega_i^l \frac{E_i}{\int_0^1 E_i di} L, \qquad K_i = \omega_i^k \frac{E_i}{\int_0^1 E_i di} K$$

$$Y = E^{1-\eta}\left(L^\alpha K^{1-\alpha}\right)^\eta, \qquad E = \int_0^1 \omega_i E_i^{1-\eta} di$$

- 'Worst-case': $\omega_i = 1$ ($L_i = L, K_i = K$).
- Efficient: $\omega_i = E_i^\eta$

Data: Korea ('91-'96) and Colombia ('81-'91)

- Manufacturing plants
- All establishments 5+ (Korea), 10+ (Colombia) workers
- Balanced panel, 31500 plants Korea, 5000 Colombia
- Revenue, labor, intermediate inputs, investment, capital
- Y = value added = revenue - intermediate inputs

Fact 1: size distribution of establishments

- Output (value-added) concentrated largest establishments

	Korea	Colombia
fraction Y largest 1%	0.57	0.30
fraction Y largest 5%	0.77	0.61
fraction Y largest 10%	0.84	0.75
fraction Y largest 20%	0.91	0.88

Fact 2: distribution of output growth rates

- Δy_{it} volatile, fat-tailed

	Korea	Colombia
$\sigma(\Delta y_{it})$	0.54	0.49
$kurtosis(\Delta y_{it})$	12.9	20.8
$iqr(\Delta y_{it})$	0.49	0.36

Fact 3: persistence of output

- y_{it} persistent, autocorrelation decays slowly

	Korea	Colombia
$corr(y_{it}, y_{it-1})$	0.93	0.96
$corr(y_{it}, y_{it-3})$	0.89	0.93
$corr(y_{it}, y_{it-5})$	0.86	0.90

Fact 4: Debt-to-GDP

- Korea: Bank of Korea Financial Statement Analysis Survey. Manufacturing, 1991-1996
- Colombia: Beck, Demirguc-Kunt, Levine (2000)

	Korea	Colombia
Debt-to-GDP	1.2	0.3

Parameterization

- Assigned parameters
  - $\gamma = 1$ (CRRA)
  - $\beta = 0.92$ (discount factor)
  - $r = 0.04$ (risk-free rate)
  - $\delta = 0.06$ (depreciation rate)
  - $\eta = 0.85$ (span of control)
  - $\alpha = 0.67$ (labor share)
- Calibrate rest to minimize distance moments model-data

Calibration

- Efficiency:

$$\ln(E_{it}) = a_{it} = z_i + a_{it}$$

  - z_i: permanent component. Bounded Pareto.

$$\Pr\left[\exp\left(z_i\right) \leq x\right] = \frac{1 - x^{-\mu}}{1 - H^{-\mu}}.$$

  - a_{it}: variable component. Fat-tailed shocks.

$$a_{it} = \rho a_{it-1} + \varepsilon_{it}$$

$$\varepsilon_{it} \sim \begin{cases} N\left(0, \sigma^2_{1,\varepsilon}\right) & \text{with prob. } 1-\kappa \\ N\left(0, \sigma^2_{2,\varepsilon}\right) & \text{with prob. } \kappa \end{cases}$$

Calibration

- Calibrate $\theta = \{\lambda, \rho, \sigma_{1,\varepsilon}, \sigma_{2,\varepsilon}, \kappa, \mu, H\}$
- Match plant-level moments and debt-to-GDP for Korea

Parameter values

λ	2.58	collateral constraint
ρ	0.74	AR(1) productivity
$\sigma_{1,\varepsilon}$	0.09	s.d. shocks
$\sigma_{2,\varepsilon}$	0.31	s.d. shocks
κ	0.07	freq. 2
μ	3.64	Pareto exponent
H	4.91	upper bound z_i

- Implies z_i accounts 2/3 variance e_i

Fit

	Korea Data	Model
$\sigma(\Delta y_{it})$	0.54	0.51
$kurtosis(\Delta y_{it})$	12.9	12.9
$iqr(\Delta y_{it})$	0.49	0.47
$corr(y_{it}, y_{it-1})$	0.93	0.95
$corr(y_{it}, y_{it-3})$	0.89	0.89
$corr(y_{it}, y_{it-5})$	0.86	0.85
fraction Y largest 1%	0.57	0.59
fraction Y largest 5%	0.77	0.83
fraction Y largest 10%	0.84	0.90
fraction Y largest 20%	0.91	0.95
Debt-to-GDP	1.2	1.2

Model predictions

- Report results for Korean calibration
- Also for US, Colombia, No external debt.
    - Same E_i process. Vary λ to match Debt-to-GDP.
- Report numbers for open and closed economies

Model predictions

	US	Korea	Colombia	No Debt
λ	50	2.6	1.2	1
Debt-to-GDP	2.3	1.2	0.3	0
Fract. constrained	0.04	0.54	0.80	0.86
$\sigma(\Delta y_{it})$	0.70	0.51	0.37	0.35

TFP losses

- Open economy:

	US	Korea	Colombia	No Debt
TFP losses, %	1.0	3.9	5.5	6.9

- Closed economy:

	US	Korea	Colombia	No Debt
TFP losses, %	0.0	0.5	3.8	5.1
r	0.04	0.04	0.02	-0.01

TFP losses

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TFP losses, %	0.0	0.5	3.8	5.1
r	0.04	0.04	0.02	-0.01

Why are TFP losses small?

- If $\ln(E_{it}) = z_i + a_{it}$ constant: no TFP losses
- Too little variability a_{it}
- TFP losses if K, L do not move at all with a_{it}:

$$\int_0^1 \exp(a_{it})\,di \qquad \text{vs.} \qquad \int_0^1 \exp(a_{it})^{1-\eta}\,di$$

  - 8.6 %

Role of micro-moments

- Illustrate role of micro facts for TFP numbers
- Set $z_i = 0$
- $a_{it} = \rho a_{it-1} + \epsilon_{it}, \epsilon_{it} \sim N(0, \sigma^2)$
- Two experiments
  1. Choose ρ, σ^2 to match $corr(y_{it}, y_{it-1})$, size distribution
  2. Set $\rho = 0.80$, choose σ^2 to match size distribution

Counterfactual experiments

	Our	1	2
$\sigma(\Delta y_{it})$	0.51	1.05	2.17
$corr(y_{it}, y_{it-1})$	0.95	0.93	0.80
$corr(y_{it}, y_{it-3})$	0.89	0.80	0.52
$corr(y_{it}, y_{it-5})$	0.85	0.69	0.34
Fraction Y top 10%	0.90	0.88	0.88
TFP loss Korea	3.9	10.5	18.3
TFP loss Colombia	5.5	18.1	29.5
'Worst-case' loss	8.6	54.3	69.9

Summarize

- Model can generate much larger TFP losses
- But miss:
  - volatility Δy_{it} in data
  - persistence Δy_{it} in data

Robustness

- Results robust to:
  - Lower $\beta(1+r)$: 0.90
  - Span-of-control: $\eta = 0.95$
  - Elasticity substitution K and L: 0.5
- TFP losses mostly driven by time-series variability of e

Model with entry/exit

- Do finance frictions distort entry/exit decision?
  - Inefficient selection into entrepreneurship
- Do finance frictions constrain young entrepreneurs?
  - High z but low initial wealth

Additional assumptions

- Each period entrepreneur decides whether
  - Work: supply 1 unit labor. Earn W
  - Entrepreneur: $Y = E^{1-\eta} \left(L^{\alpha} K^{1-\alpha}\right)^{\eta}$
- Exogenous exit hazard: $1 - p$
- Measure $1 - p$ young agents:
  - Draw z_i, $B = 0$

Dynamic program

$$\pi(b) = \max_{k,l} \left(l^{\alpha} k^{1-\alpha} \right)^{\eta} - (1+r) Wl - (r+\delta) k$$

$$\text{s.t.} \quad Wl + k \leq \lambda b$$

$$V(b,e) = \max_{b'} \frac{c^{1-\gamma}}{1-\gamma} + \beta \int \exp(e'-e)^{1-\gamma} V\left(\frac{b'}{\exp(e'-e)}, e' \right) d\Phi(e'|e)$$

where

$$c = (1+r) b + \max \left[\pi(b), \frac{W}{\exp(e)} \right] - b'.$$

Parametrization

- Additional parameter: p
  - Same set of moments as earlier (use entire panel)
  - Add exit hazards, age, share output by exiting plants

Economy with no initial endowment

	Korea Data	Model
$\sigma(\Delta y_{it})$	0.56	0.57
$corr(y_{it}, y_{it-1})$	0.92	0.93
$corr(y_{it}, y_{it-5})$	0.86	0.74
fraction Y largest 5%	0.72	0.66
fraction Y largest 20%	0.87	0.89
fraction age 1-5	0.51	0.62
fraction age 6-10	0.26	0.16
fraction age > 10	0.23	0.21
exit hazard	0.33	0.25
output share if exit	0.07	0.07
Debt-to-GDP	1.2	1.2

TFP losses

- Open economy:

	US	Korea	Colombia	No Debt
TFP losses, %	5.6	15.1	20.7	22.6

- Closed economy:

	US	Korea	Colombia	No Debt
TFP losses, %	3.1	15.6	23.2	28.7

TFP losses

- Open economy:

	US	Korea	Colombia	No Debt
TFP losses, %	5.6	15.1	20.7	22.6

- Closed economy:

	US	Korea	Colombia	No Debt
TFP losses, %	3.1	15.6	23.2	28.7

Why TFP losses larger?

- Talented young entrepreneurs enter almost immediately
  - Initially very constrained

- Question: are entering plants constrained data?
- Compare Δy, returns to capital young vs. old plants

Young vs. Old plants

	Korea Data	Model
Δy ages 1-5 vs. 10+	0.05	0.20
Δy ages 6-10 vs. 10+	0.02	0.06
Y/K ages 1-5 vs. 10+	0.04	0.30
Y/K ages 1-5 vs. 10+	0.06	0.17

Young much more 'constrained' in the model

Mechanical fix

- Assume initial endowment $B = \phi \times (WL^*(z_i) + K^*(z_i))$
- Choose $\phi = 0.35$ to match growth rates, Y/K young

Economy with initial endowment

	Korea Data	Model
Δy ages 1-5 vs. 10+	0.05	0.06
Δy ages 6-10 vs. 10+	0.02	0.01
Y/K ages 1-5 vs. 10+	0.04	0.10
Y/K ages 1-5 vs. 10+	0.06	0.05

TFP losses

- Open economy:

	US	Korea	Colombia	No Debt
TFP losses, %	1.7	4.7	6.3	6.6

- Closed economy:

	US	Korea	Colombia	No Debt
TFP losses, %	0.5	5.2	8.7	9.9

TFP losses

- Open economy:

	US	Korea	Colombia	No Debt
TFP losses, %	1.7	4.7	6.3	6.6

- Closed economy:

	US	Korea	Colombia	No Debt
TFP losses, %	0.5	5.2	8.7	9.9

Role of fixed costs

- Do fixed costs prevent internal accumulation?
- Assume $Y = A^{1-\eta}\left((L-\bar{L})^{\alpha}K^{1-\alpha}\right)^{\eta}$
- Choose $\bar{L}$ to match L vs. Y relationship data
  - Regress $\ln\left(\frac{Y}{L}\right)$ on $\ln(Y)$: 0.13 (vs. ≈ 0 absent fixed costs)
- Need $\bar{L} = 0.06$ of aggregate labor used.

Role of fixed costs

- Increase TFP losses, but not much:

	No fixed cost	Fixed Cost
Δy ages 1-5 vs. 10+	0.06	0.08
Δy ages 6-10 vs. 10+	0.01	0.03
Y/K ages 1-5 vs. 10+	0.10	0.15
Y/K ages 1-5 vs. 10+	0.05	0.10
TFP losses US	1.5%	1.6 %
TFP losses Korea	5.1%	5.7 %
TFP losses Colombia	6.7%	7.1 %

Conclusions

- Model that accounts plant-level data:
    - Small TFP losses from misallocation
- Missing ingredients:
    - Technology adoption / innovation: level, not dispersion $\tilde{r}$
    - Differences in access to finance across entrepreneurs
    - Other shocks that break correl. net worth and productivity
    - Agency problems within firm

Alternative specification exit/entry

- So far: assumed initial endowment to match data
- Alternative setup:
  - zero exogenous exit hazard
  - z changes infrequently

$$z_{i,t} = \begin{cases} z_{i,t-1} \text{ with prob. } 1 - p_z \\ \rho_z z_{i,t-1} + (1-\rho_z)\, z^*_{i,t} \text{with prob. } p_z \end{cases}$$

  - Model without exit: $\rho_z = 1$. Another extreme: $\rho_z = 0$

Economy with $\rho_z = 0$

	Korea Data	Model
Δy ages 1-5 vs. 10+	0.05	0.08
Δy ages 6-10 vs. 10+	0.02	0.05
Y/K ages 1-5 vs. 10+	0.04	0.18
Y/K ages 1-5 vs. 10+	0.06	0.15
output share exiting plants	0.07	0.07
TFP gap Korea, %		8.4
TFP gap no finance, %		12.7