Misallocation and Establishment Dynamics

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Motivation

Regulations and other market frictions cause a gap between marginal revenues and marginal costs (distortions or wedges), which potentially lowers aggregate productivity through inefficient

1. allocation of resources (Hsieh and Klenow, 2009; Restuccia and Rogerson, 2008)

2. technology choice (Midrigan and Xu, 2012)

3. entry and exit (Restuccial and Rogerson, 2008)

To what extent?

Aim

- To offer new evidence on the effects of establishment-level distortions on
  (1) aggregate productivity
  (2) size distribution
  (3) establishment-level productivity growth
  (4) entry/exit

- To explore the factors that affect establishment-level distortions

What we do

1. Using establishment-level data from Japanese manufacturers, we measure establishment-level distortions following Hsieh and Klenow (2009).

2. Using measured establishment-level distortions, we calculate the hypothetical aggregate TFP and hypothetical size distribution that would be realized without distortions.

3. We estimate the effects of distortions on establishment entry and exit and on subsequent establishment-level productivity growth.

4. We regress distortions on proxies for regulations, external finance constraints, and labor market frictions.

What we find

1. If capital and labor were reallocated in Japanese manufacturing industries to equalize marginal products to the extent observed in the U.S. manufacturing industries, aggregate total factor productivity (TFP) would rise by 6.2%.

2. The efficient establishment size distribution would be more dispersed than the actual one.

3. Distortions have significant impacts on entry and exit, and establishment-level productivity growth.

4. Financial frictions is a source for capital distortions.

Related Literature

- Literature on the effects of distortions on aggregate productivity (Hsieh and Klenow, 2009; Restuccia and Rogerson, 2008; Bartelsman et al., 2013)

- Literature on the misallocation of credit in the 1990s's Japan (Caballero et al., 2008)

Composition

1. Introduction

2. Measurement of Distortions and Their Effects on Aggregate TFP, Plant-Size Distribution, Entry/Exit, and Establishment-level Productivity Growth

3. Factors for Establishment-level Distortions

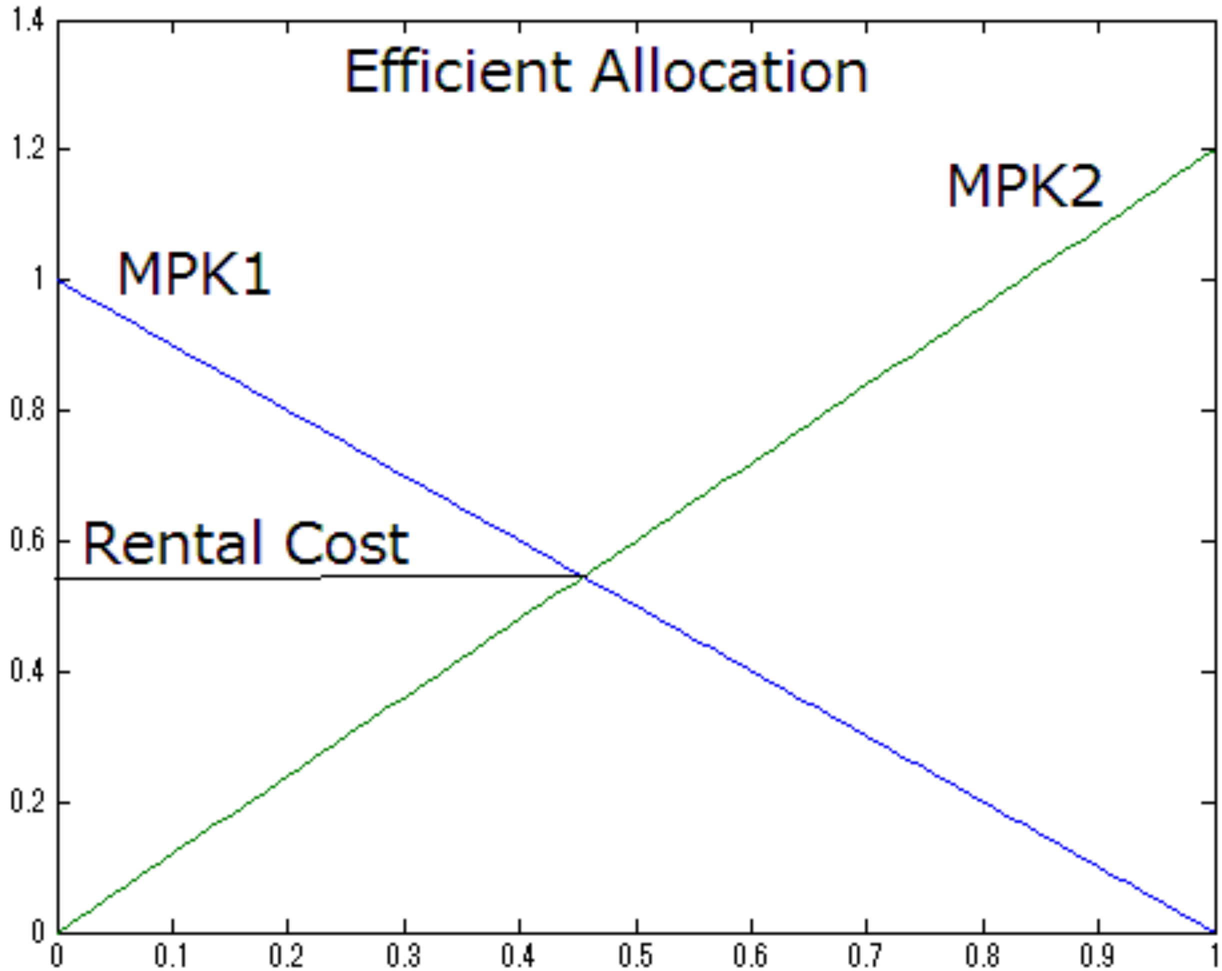
4. Conclusion

Composition

1. Introduction
2. **Measurement of Distortions and Their Effects on Aggregate TFP, Plant-Size Distribution, Entry/Exit, and Establishment-level Productivity Growth**
3. Factors for Establishment-level Distortions
4. Conclusion

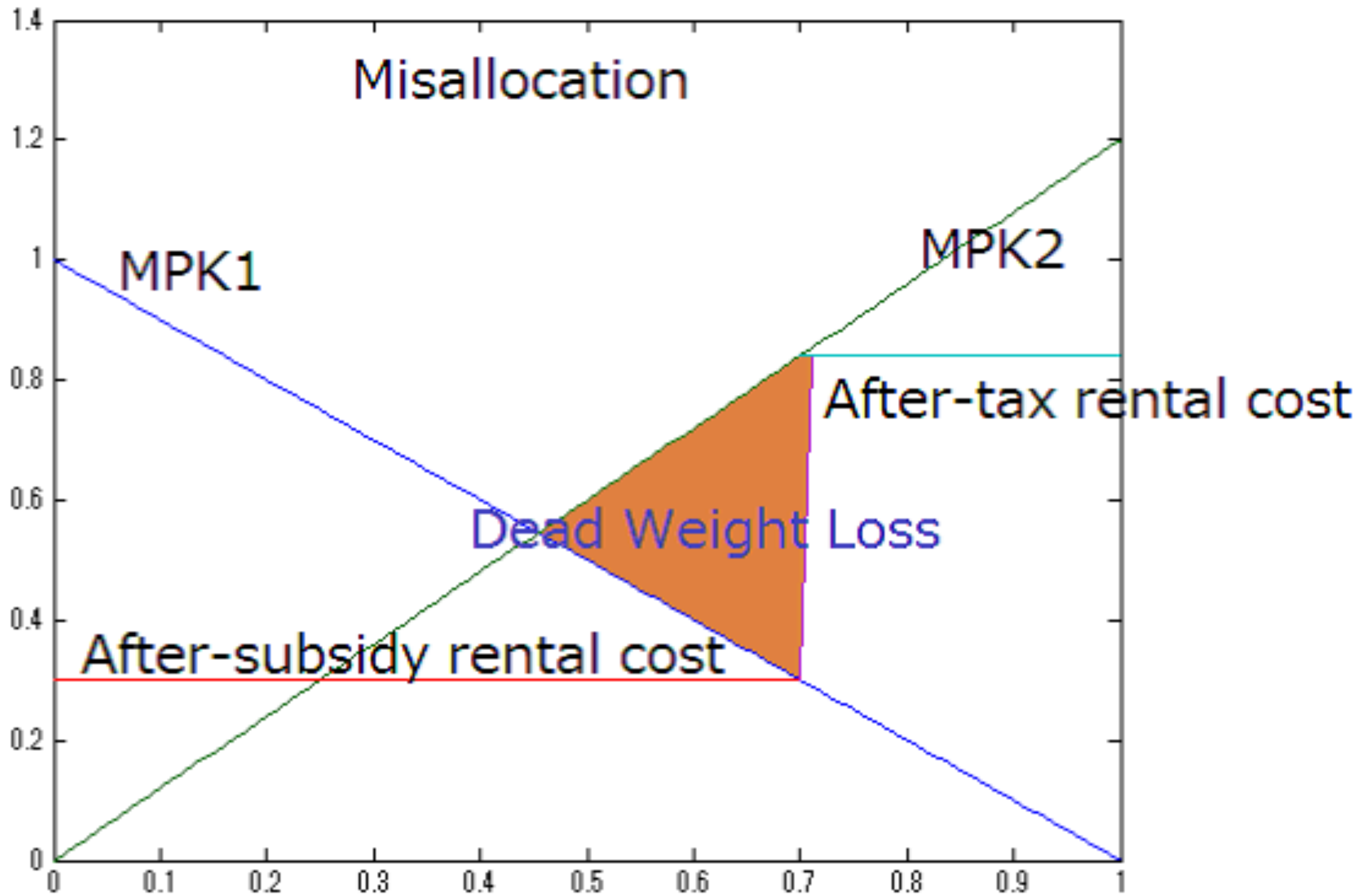
How to measure distortions: Intuition

If allocation is efficient, MPK is equalized at rental cost.



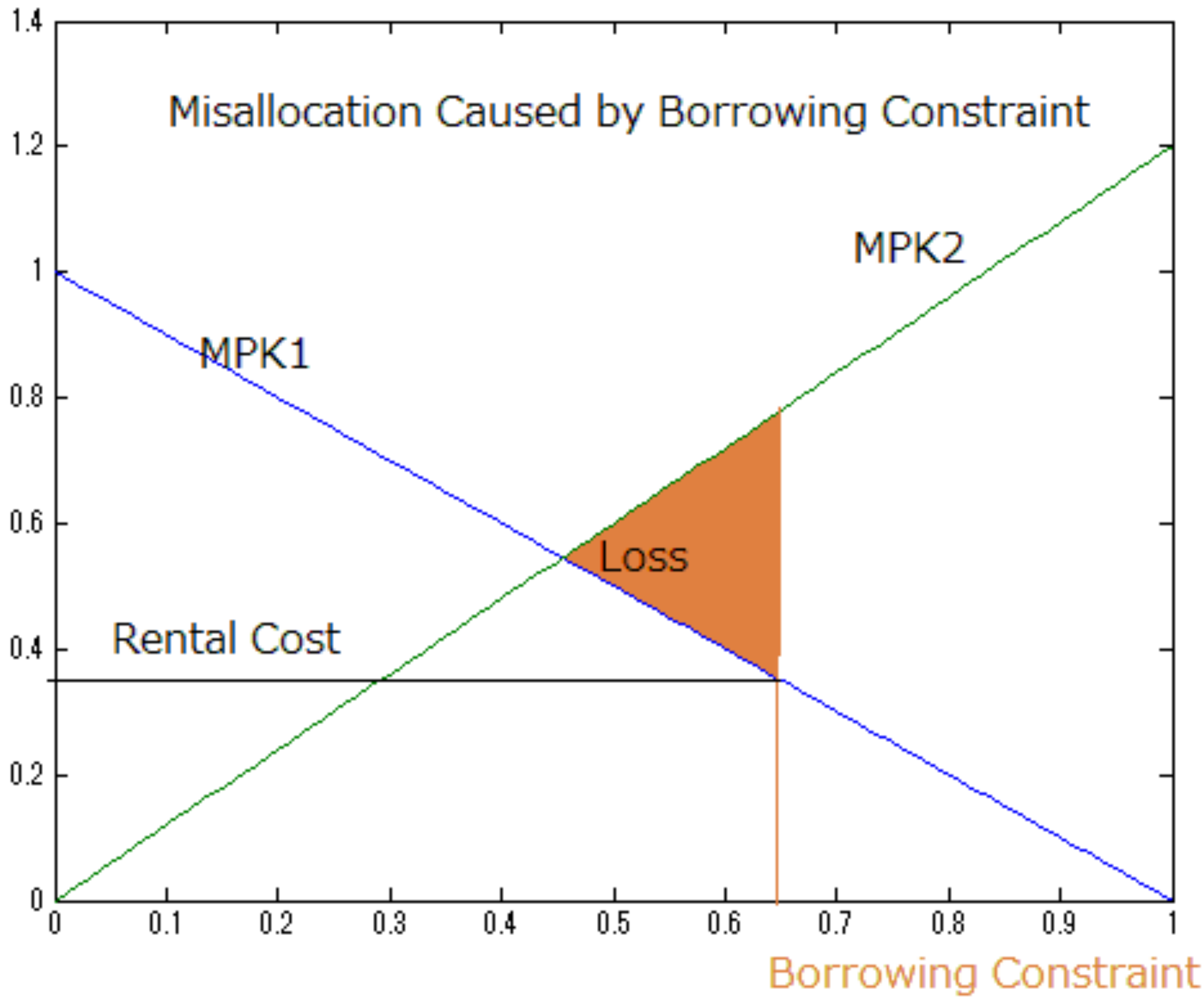
How to measure distortions: Intuition

If allocation is inefficient, MPK differs across establishments, resulting in lower aggregate production and productivity.



How to measure distortions: Intuition

Distortion is caused not only by taxes and subsidies but also by regulations and market frictions.



How to measure distortions

We allow for market power (monopolistic competition) and for two sorts of distortions (capital and output, or equivalently, capital and labor)

Measurement

We follow Hsieh and Klenow (2009). A static, partial-equilibrium, monopolistic competition model with exogenous output and capital distortions.

There are a final good producer, representative industrial good producers, one for each industry, and many differentiated good producers.

Measurement: Final good and industrial good producers

The final good producer combines the output Y_s of industry $s \in \{1, ..., S\}$ and produces Y using a Cobb-Douglas production technology,

$$Y = \prod_{s=1}^{S} Y_s^{\theta_s}, \ \ where \sum_{s=1}^{S} \theta_s = 1.$$

Industry good producer s combines differentiated good $si \in \{1, ..., M_s\}$ to produce industry output Y_s using a CES production technology,

$$Y_s = \left(\sum_{i=1}^{M_s} Y_{si}^{\frac{\sigma_S - 1}{\sigma_S}} \right)^{\frac{\sigma_S}{\sigma_S - 1}}, \quad \sigma_s > 1$$

The price elasticity of demand for differentiated good is σ_S: $P_{si} = P_S Y_S^{\frac{1}{\sigma_S}} Y_{si}^{-\frac{1}{\sigma_S}}$

Measurement: Differentiated Good Producers

Producer si produces a differentiated good Y_{si} from capital K_{si} and labor L_{si} using a constant returns to scale Cobb-Douglas production technology with idiosyncratic TFP, A_{si},

$$Y_{si} = A_{si} K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}$$

Producer si faces idiosyncratic output and capital distortions, τ_{Ysi} and τ_{Ksi}, and maximizes his profits:

$$\Pi_{si} = (1 - \tau_{Ysi}) P_{si} Y_{si} - w L_{si} - (1 + \tau_{Ksi}) R K_{si}$$

Measurement: Why Not Distortions on Labor?

We can identify only two of output, labor, and capital distortions from the FOCs.

Suppose alternatively that producer si faces labor distortion τ^*_{Lsi} and capital distortion τ^*_{Ksi}. Our measures can be interpreted as being ”standardized” by one plus labor distortion.

$$1 - \tau_{Ysi} = \frac{1}{1+\tau^*_{Lsi}}$$
$$1 + \tau_{Ksi} = \frac{1+\tau^*_{Ksi}}{1+\tau^*_{Lsi}}.$$

Which specification we choose does not affect our measures of aggregate TFP efficiency (TFPGAIN or TFPGAP) or the plant-size distributions that would be realized if we removed distortions.

Measurement: Measuring Producer-Level Distortions and Productivity

From producer si's optimal decision and demand function, we obtain

$$1 + \tau_{Ksi} = \frac{\alpha_s}{1-\alpha_s} \frac{wL_{si}}{RK_{si}}$$

$$1 - \tau_{Ysi} = \frac{\sigma_s}{\sigma_s - 1} \frac{wL_{si}}{(1-\alpha_s) P_{si} Y_{si}}$$

$$A_{si} = \kappa_s \frac{(P_{si}Y_{si})^{\frac{\sigma_s}{\sigma_s - 1}}}{K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}},$$

We can retrieve τ_{Ksi}, τ_{Ysi} and A_{si} from observable data given R and σ.

We call A_{si} "physical productivity" or "TFPQ" and distinguish it from the "revenue-based productivity" or "TFPR" ($\equiv P_{si} A_{si}$) .

$$TFPR_{si} = \left(\frac{\sigma}{\sigma - 1}\right) \left(\frac{R}{\alpha_s}\right)^{\alpha_s} \left(\frac{w}{1-\alpha_s}\right)^{1-\alpha_s} \frac{(1+\tau_{Ksi})^{\alpha_s}}{1-\tau_{Ysi}}.$$

Measurement: Aggregate TFP

Once we have measured producer-level distortions and TFPQ, it is straightforward to derive aggregate TFP.

Without distortions, revenue-based productivity (TFPR) would be equalized across producers even though physical productivity (TFPQ) differs: a more productive producer operates at a larger scale and sells its product at a lower price.

To the extent that revenue-based productivity differs across producers, aggregate TFP is lower than the efficient aggregate TFP, which would be achieved without any distortions.

Aggregate TFP depends on the deviation of $TFPR_{si}$ from its industry average for each industry.

Measurement: Aggregate TFP: Definitions

Efficient aggregate TFP=Hypothetical aggregate TFP that would be realized without capital or output distortions.

$TFPGAP$=Actual aggregate TFP/Efficient aggregate TFP.

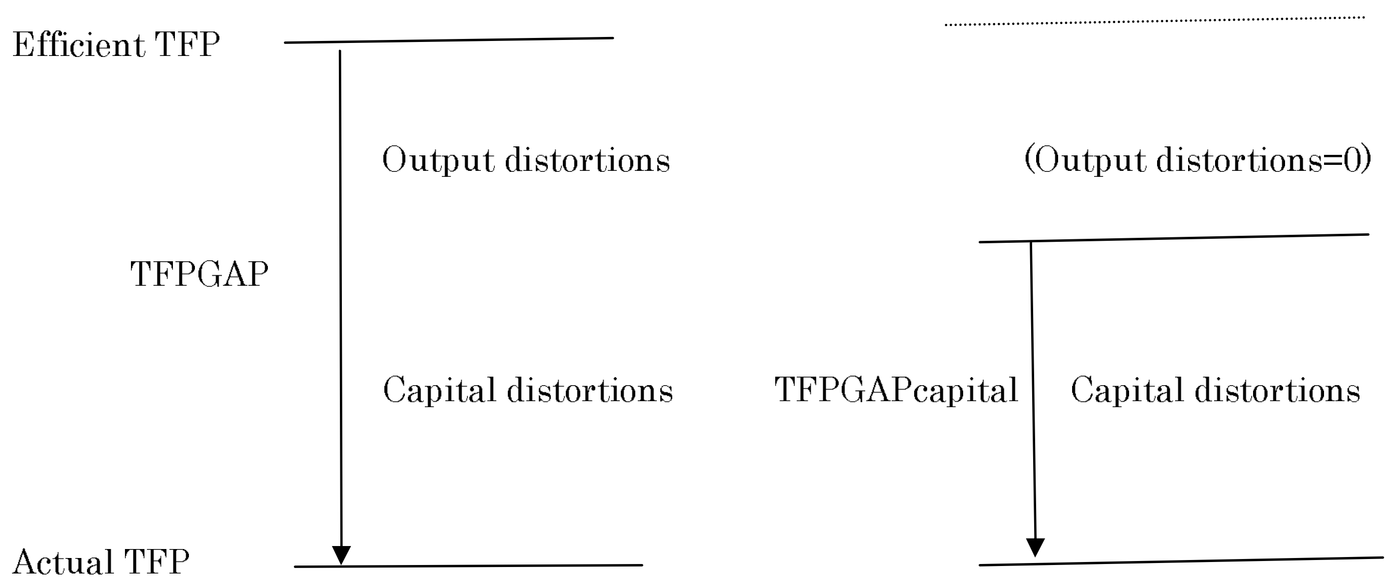
$TFPGAIN$=1/TFPGAP-1.

Since we will analyze borrowing constraints that result in capital distortions, we also define the followings:

$TFPGAP_{capital}$=Actual aggregate TFP/Hypothetical aggregate TFP that would be realized without output distortions only.

$TFPGAIN_{capital}$=1/$TFPGAP_{capital}$-1.

Measurement: Aggregate TFP: Definitions



Measurement: Notes on TFPGAP

1. TFP gap is an efficiency measure given the market structure of monopolistic competition (i.e., given σ_S).

2. TFP gap measures the allocation efficiency and as such reflects the variation in, not the average of, distortions across producers,in contrast with ”business cycle accounting” (e.g., Chari et al., 2007).

3. TFP gap is a measure of allocation efficiency given total resources.

Measurement: Size Distribution

Distortions affect the size distribution, since

$$log(Y_{si}) = \sigma_s log(1 - \tau_{Y\,si}) - \alpha_s \sigma_s log(1 + \tau_{K\,si}) + \sigma_s log(A_{si}) + const,$$

$log(Y_{si})$ tends to be more dispersed

- if either type of distortions are more dispersed,
- if either type of distortions are less positively (or more negatively) correlated with TFPQ, or
- if the two distortions are more positively (or less negatively) correlated with each other.

Measurement: Data

We use the plant-level data underlying the *Census of Manufacturing* that spans from 1981 to 2008.

Coverage: All establishments falling into manufacturing industries and located in Japan. We restrict our sample firms to those with tangible fixed asset data: plants with 10 or more employees for 1981-2000 and 2005, 30 or more employees for 2001-04 and 2006-08.

Labor quality: We adjust the quality of workers and hours worked assuming that they are reflected by plant-level annual, per-worker wage relative to its industry average.

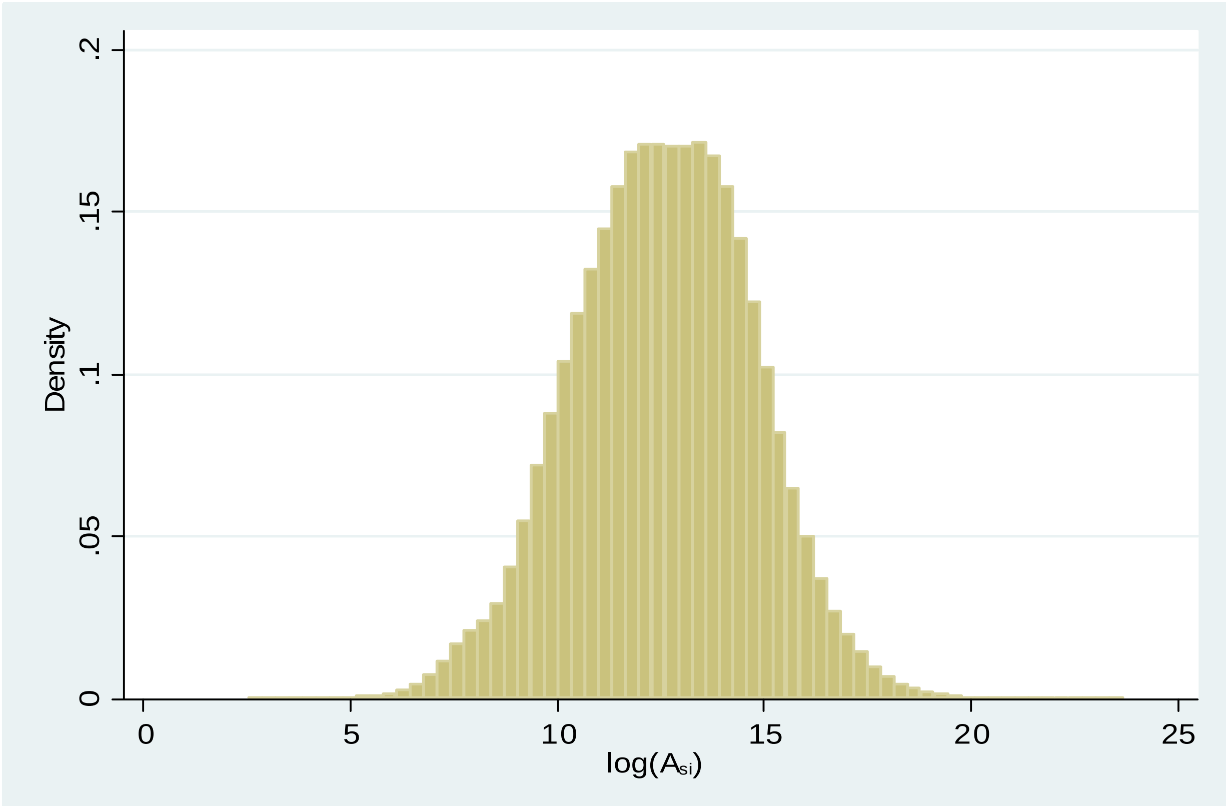
Parameters: We set $R = 0.1$. We set σ_S based on Broda and Weinstein (2006) as a baseline. (4.8, 3.4, and 2.5 for 1981-1989 and 3.5, 2.9, and 2.1 for 1990-2008 for commodity, reference-priced, and differentiated goods, respectively) as a baseline case. Alternatively, we also set$\sigma = 3$ to compare with Hseih and Klenow (2009).

Measurement: Data

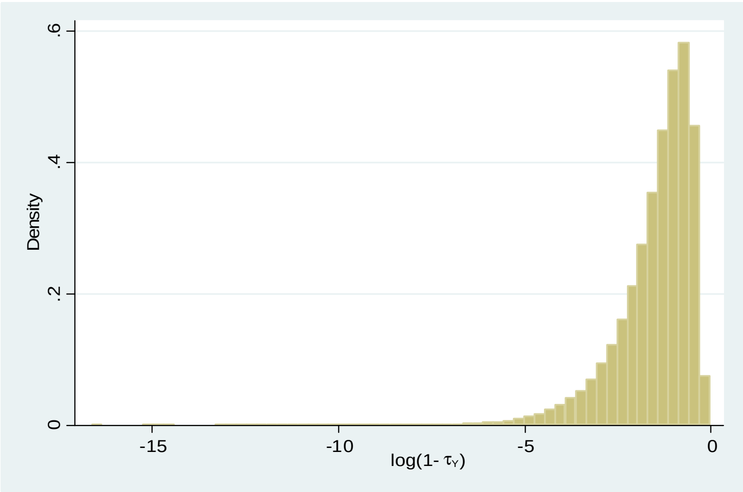
Outliers: We trim the 1% tails of marginal revenue of capital, marginal revenue of labor, and TFPQ, all standardized by industry average.

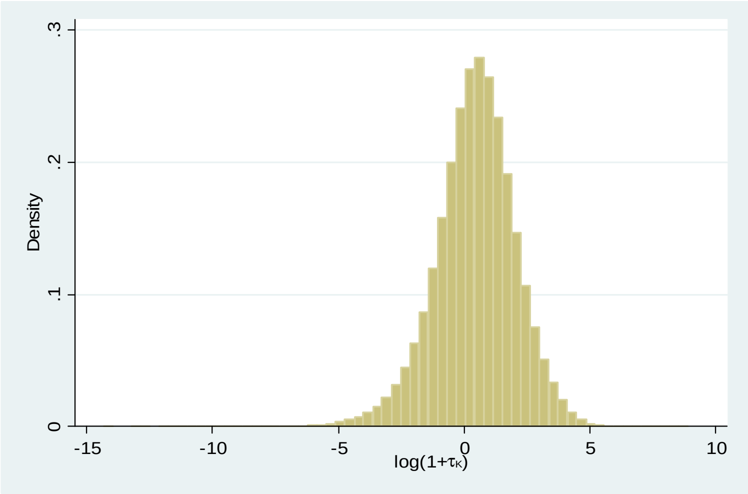
Number of total plant-year observations: 3,565,341.

Measurement: Distribution of $log(A_{si})$



Measurement: Distribution of $log(1-\tau_{Ysi})$ and $log(1+\tau_{Ksi})$





Measurement: TFPGAP and TFPGAIN

Elasticity of substitution	Japan Baseline	$\sigma = 3$	United States
Output distortions and capital distortions=0			
$TFPGAP$	0.717	0.690	0.733
$TFPGAIN$	39.6%	44.9%	36.60%
Output distortions=0			
$TFPGAP_{capital}$	0.826	0.821	N.A.
$TFPGAIN_{capital}$	21.1%	21.7%	N.A.

If capital and labor were reallocated in Japan to equalize marginal products to the extent observed in the US, manufacturing TFP in Japan would increase by 6.2%.

Capital distortions account for about half of the total TFPGAIN.

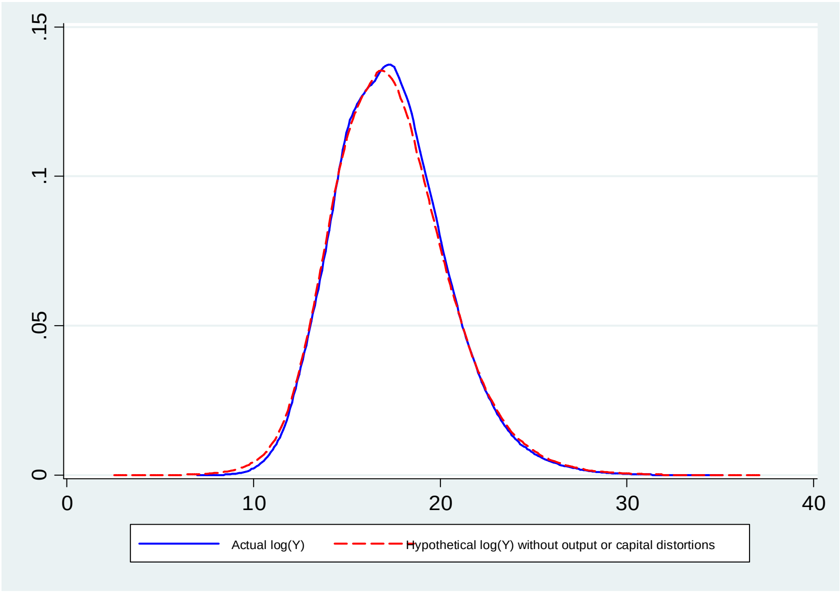
Measurement: TFPGAIN and TFPGAP

Japan's allocation efficiency is worse than that of the U.S., and much better than China and India, which would increase aggregate TFP by 30-50% and 40-60%, respectively, if their resources were reallocated to the efficiency level of the US (Hsieh and Klenow, 2009).

To examine whether our result for Japan's TFPGAIN is plausible, we use the country ranking on ease of doing business, provided in World Bank (2012), although far from an accuracy proxy for allocation efficiency: The United States, Japan, China, and India rank in 4th, 20th, 91th, and 132th place, respectively.

Measurement: Actual and Efficient Size Distributions

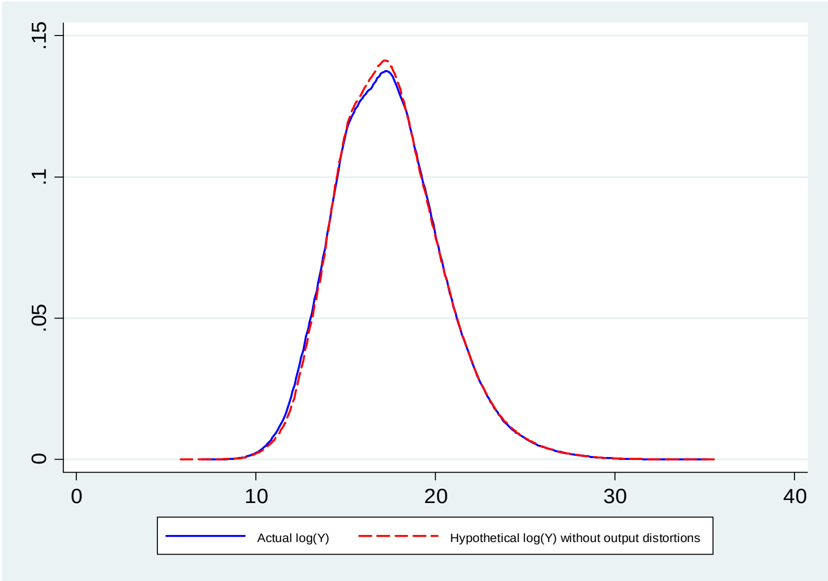
Removing both distortions would make the size distribution more dispersed.



Density of Actual $log(Y_{si})$ (Blue Line) and the Hypothetical $log(Y_{si})$ for $\tau_{Ysi} = \tau_{Ksi} = 0$ (Red Line).

Measurement: Actual and Efficient Size Distributions

Removing only output distortions would make the size distribution more concentrated.



Density of Actual $log(Y_{si})$ (Blue Line) and the Hypothetical $log(Y_{si})$ for $\tau_{Ysi} = 0$ (Red Line).

Measurement: Distribution of output: Actual and Hypothetical in the Case of No Distortions

Without distortions, the largest establishments (top 0.01% to top 20%) should have a larger share, while the smallest establishments (bottom 20%) should have a smaller share.

	(1) Actual output	(2) $\tau_{Ysi} = 0$ $\tau_{Ksi} = 0$	(3) $\tau_{Ysi} = 0$
Interquartile range	3.935	4.024	3.871
25th percentile	15.266	15.173	15.333
75th percentile	19.201	19.198	19.204
Output share of largest 0.01% of establishments	39.13%	58.93%	47.16%
Output share of largest 0.1% of establishments	76.17%	86.86%	81.38%
Output share of largest 1% of establishments	95.38%	97.93%	96.63%
Output share of largest 5% of establishments	99.03%	99.62%	99.31%
Output share of largest 10% of establishments	99.59%	99.84%	99.71%
Output share of largest 20% of establishments	99.86%	99.95%	99.90%
Output share of smallest 1% of establishments	0.00000%	0.00000%	0.00000%
Output share of smallest 5% of establishments	0.00003%	0.00001%	0.00003%
Output share of smallest 10% of establishments	0.00014%	0.00004%	0.00012%
Output share of smallest 20% of establishments	0.00075%	0.00024%	0.00058%

Measurement: Robustness: Subperiods

Allocation efficiency tended to worsen during the past three decades.

	1981-2008 (Baseline)	1981-89	1990-99	2000-08
Actual size distribution				
Interquartile range	3.935	2.635	2.992	3.586
Output share of largest 1% of establishments	95.38%	79.66%	92.26%	90.36%
Output share of smallest 20% of establishments	0.001%	0.04%	0.004%	0.002%
Output distortions and capital distortions=0				
$TFPGAP$	0.717	0.733	0.716	0.701
$TFPGAIN$	39.56%	36.42%	39.67%	42.71%
Interquartile range	4.024	3.009	3.316	3.919
Output share of largest 1% of establishments	97.93%	82.97%	94.03%	95.73%
Output share of smallest 20% of establishments	0.000%	0.017%	0.002%	0.000%
Output distortions=0				
$TFPGAP_{capital}$	0.826	0.838	0.832	0.808
$TFPGAIN_{capital}$	21.05%	19.32%	20.25%	23.77%
Interquartile range	3.871	2.586	2.970	3.609
Output share of largest 1% of establishments	96.63%	79.73%	93.22%	92.66%
Output share of smallest 20% of establishments	0.001%	0.040%	0.004%	0.001%

Measurement: Robustness: Subperiods

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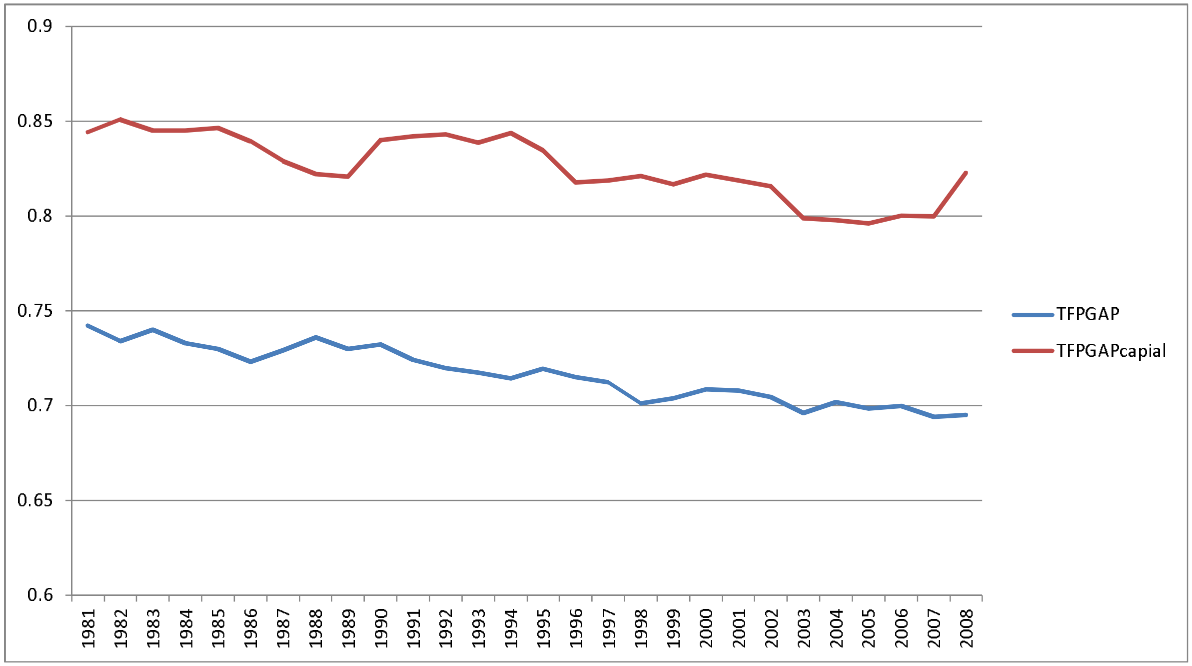

$TFPGAP(\tau_{Ysi} = \tau_{Ksi} = 0)$ and $TFPGAP_{capital}(\tau_{Ysi} = 0)$.

Measurement:Robustness

	(1) Baseline	(2) 1981-2000 and 2005	(3) Trimming $\pm 2\%$
Actual size distribution			
Interquartile range	3.935	3.640	3.887
Output share of largest 1% plants	95.38%	95.40%	94.14%
Output share of smallest 20% plants	0.001%	0.001%	0.001%
Output distortions and capital distortions=0			
TFPGAP	0.717	0.722	0.760
TFPGAIN	39.56%	38.49%	31.63%
Interquartile range	4.024	3.751	3.944
Output share of largest 1 % plants	97.93%	97.14%	97.09%
Output share of smallest 20 % plants	0.0002%	0.001%	0.000%
Output distortions=0			
TFPGAPcapital	0.826	0.832	0.866
TFPGAINcapital	21.05%	20.16%	15.48%
Interquartile range	3.871	3.565	3.825
Output share of largest 1 % plants	96.63%	96.25%	95.52%
Output share of smallest 20 % plants	0.0006%	0.001%	0.001%

Entry and Exit

Distortions may either

- promote exit by lowering profitability, or
- hinder entry/exit by giving incumbents higher rents.

Exit

We estimate

$$
\begin{aligned}
& Prob(Exit_{sit} = 1) \\
= \;& \beta_1 \overline{TFPR}_{st-1} + \beta_2 \frac{TFPQ_{sit-1}}{TFP_{st-1}} \\
+ \;& \beta_3 log(1 - \tau_{Y sit-1}) + \beta_4 log(1 + \tau_{K sit-1}) \\
+ \;& \beta_5 log(age_{sit-1}) + yeardummy_t + industrydummy_s + \epsilon_{sit},
\end{aligned}
$$

where $\overline{TFPR}_s$ denotes the industry average of both types of distortions.

Probit Estimation of Exit Probability

A higher industry-level average of distortions ($TFPR_s$) *lowers* exit probability, while higher establishment-level distortions within an industry *heighten* exit probability.

	Marginal Effect	Robust Std. Err.
$TFPR_s$	-0.017	0.004***
$TFPQ_{si}/TFPQ_s$	-0.027	0.003***
$log(1-\tau_{Ysi})$	-0.023	0.005***
$log(1+\tau_{Ksi})$	0.013	0.001***
$log(age)$	-0.020	0.004***
$(log(age))^2$	-0.006	0.006
$(log(age))^3$	0.003	0.003
$(log(age))^4$	0.000	0.001
constant		
year dummy	Yes	
industry dummy	Yes	
Number of Obs.	2612536	
Pseudo R-squared	0.079	

Entry

$$Entry_{st} = \beta_1 \overline{TFPR}_{st} + industry_s + year_t + \epsilon_{st},$$

Random-effect Model

	Coef.	Std. Err.
$TFPR_{st}$	-0.0001	0.00003***
Constant	0.2039	0.01475***
Year dummy	Yes	
Industry dummy	Yes	
Number of obs.	1001	
R-squared within	0.4104	
R-squared between	1	
R-squared overall	0.5252	

A higher industry average of distortions lowers the entry rate.

Establishment-level Productivity Growth

Distortions may affect establishment-level productivity growth ($GTFPQ$). For example, Midrigan and Xu (2012) posit that financial frictions affect technology adoption and thus productivity.

$$GTFPQ_{si} = \beta_0 + \beta_1 \frac{TFPQ_{si0}}{TFPQ_{s0}} + \beta_2 log(1 - \tau_{Ysi0})$$
$$+\beta_3 log(1 + \tau_{Ksi0}) + year_0 + industry_s + \epsilon_{it},$$

where $GTFPQ_{si}$ is the average growth rate of establishment i over the years after entrance.The subscript 0 denotes the year when the establishment enters the market.

Establishment-level Productivity Growth

Establishment-level distortions have negative impacts on productivity growth subsequent to entry.

Period	1981-2008			1981-2000		
	Coeff.	Std. Err.		Coeff.	Std. Err.	
$TFPQ_{si}/TFPQ_s$	-0.032	0.001	***	-0.027	0.001	***
$log(1-\tau_{Ysi})$	0.088	0.002	***	0.093	0.002	***
$log(1+\tau_{Ksi})$	-0.032	0.001	***	-0.035	0.001	***
Constant	-0.027	0.008	***	-0.017	0.008	**
Year dummy	yes			yes		
Industry dummy	yes			yes		
Number of obs.	328983				316293	
F(81,328901)	519.08				541.88	
Prob $>$ F	0				0	
R-squared	0.1133				0.1112	
Adj. R-squared	0.1131				0.111	
Root MSE	0.40441				0.4042	

Sources of Distortions

A number of preceding studies focus on financial frictions as a source of distortions (Jeong and Townsend,2007; Amaral and Quintin, 2010; Buera et al., 2011; Moll 2010; Midrigan and Xu, 2012; Gilchrst et al., 2012; Greenwoowd et al, 2012; Pratap and Urrutia, 2012).

If the supply of external finance is limited due to informational or contractual frictions, then establishments that are more dependent on external finance are likely to be subject to greater distortions.

Following Rajan and Zingales (1998), we measure external finance dependence as the difference between capital expenditures and cash flow from operations divided by capital expenditures.

We use the industry-level median of external finance dependence using a dataset of Japanese listed firms over the period of 1981-2007.

Sources of Distortions

$$Distortion_{sit} = \beta Fin_s + \gamma X_{sit} + \alpha Year_t + \epsilon_{sit},$$

where $Distortion_{sit}$, is either $TFPRGAP_{sit} \equiv \frac{(1+\tau_{Ksit})^{\alpha_s}}{1-\tau_{Ysit}}$, τ_{Ysit}, or τ_{Ksit}, Fin_s is our measure of external finance dependence, and X_{sit} is a vector of establishment- and industry-specific control variables.

	$TFPRGAP_{sit}$	$\tau_{Y sit}$	$\tau_{K sit}$	$\tau_{K sit}$
External finance dependence	0.772	1.071	1.238	1.252
	(0.226)***	(0.362)***	(0.688)*	(0.689)*
Log (age)				-0.181
				(0.026)***
Log($TFPQ_{si}$)	0.168	0.398	-0.222	-0.219
	(0.043)***	(0.097)***	(0.075)***	(0.074)***
Regulation index	0.212	0.297	-0.007	-0.005
	(0.135)	(0.282)	(0.376)	(0.377)
Export dummy	0.041	0.091	-0.141	-0.141
	(0.016)**	(0.036)**	(0.063)**	(0.064)**
Log(number of employees)	-0.104	-0.199	-0.413	-0.395
	(0.037)***	(0.084)**	(0.095)***	(0.095)***
Corporation dummy	0.004	-0.204	0.773	0.768
	(0.054)	(0.123)	(0.167)***	(0.166)***
Sole proprietorship dummy	-0.257	-1.099	2.086	2.068
	(0.058)***	(0.157)***	(0.255)***	(0.253)***
Share of workers aged 20-29	14.312	22.725	-12.288	-12.095
	(4.687)***	(9.318)**	(19.020)	(18.972)
Share of workers aged 30-39	12.624	22.558	-19.893	-19.587
	(5.188)**	(9.985)**	(14.391)	(14.383)
Share of workers aged 40-49	13.657	21.014	-6.484	-6.388
	(4.860)***	(9.551)**	(16.887)	(16.848)
Share of workers aged 50-59	16.247	29.214	-28.894	-28.445
	(4.988)***	(9.826)***	(15.528)*	(15.503)*
Share of workers aged 60+	14.117	25.701	-16.444	-16.157
	(4.849)***	(9.470)***	(16.660)	(16.626)
Share of part-time workers	-0.143	-0.474	2.331	2.276
	(0.499)	(0.947)	(1.914)	(1.910)
Constant	-14.398	-27.448	20.008	19.685
	(4.592)***	(8.815)***	(15.322)	(15.297)

Sources of Distortions: Results

- External finance dependence takes a positive and marginally significant coefficient in all the regressions.

- Firm age takes a negative and significant coefficient in the regression of τ_{Ksit}, suggesting financial constraints.

- Log(TFPQ) and export dummy take a positive and significant coefficient in the regressions of $TFPRGAP_{sit}$ and τ_{Ysit}, while they take a negative and significant coefficient in the regressions of τ_{Ksit}.

- Regulation index is not significant.

- All the variables representing the share of workers in each of the age groups (with under 20s as the reference group) takes positive and significant coefficients in the regressions for $TFPRGAP_{sit}$ and τ_{Ysit}.

Conclusion: Findings

1. If capital and labor were reallocated in Japanese manufacturing industries to equalize marginal products to the extent observed in the U.S. manufacturing industries, aggregate total factor productivity (TFP) would rise by 6.2%.

2. The efficient establishment size distribution would be more dispersed than the actual one.

3. Industry-level distortions have significant negative impacts on entry and exit in the industry, while establishment-level distortions have a significant positive impact on the probability of the establishment's exit.

4. Establishment-level distortions have a significant negative impact on the establishment's productivity growth subsequent to entry.

5. Financial frictions and aging of workers result in distortions.

Conclusion: Future Work

- To build a structural model that incorporate financial frictions.
- To estimate the impact of policies that aim at alleviating financial frictions.

Policy Implications

Removing distortions would enhance aggregate productivity through the improvement of resource allocations and technology choice, increase the establishment metabolism, and enhance the competitiveness of Japanese firms. For this aim, the following reforms will be helpful.

- To keep the financial system stable so that financial constraints do not become tightened.
- To improve credit availability for young firms.
- To make the labor market more flexible so that labor reallocation among establishments and firms become more active.
- To reform the wage system so that marginal revenues and costs of labor for each age class of workers equalize.