Revisiting Productivity Differences and Firm Turnover

-Evidence from product-based TFP measures in the Japanese Manufacturing Industries-

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1. Introduction

- **Two empirical issues in productivity analysis at the firm-level data:**

(1) There are persistent productivity differences between firms.

(2) Entries and exits of firms affect the aggregate productivity.

1. Introduction

- **Contributions by Foster, Haltiwanger, and Syverson (2008, "FHS"):**

  Traditional measures of TFP are mixed ones that also include demand factors. Using physical output, they measured purified TFP that excluded demand factors. Based on such measure, they reexamined how much of the selection mechanism of firms is caused by technological efficiencies or by demand factors.

- **Analysis of FHS:**

  Eight homogeneous products are chosen from Census of Manufactures. TFP on the basis of physical output is measured and compared to traditional TFP measures.

1. Introduction

Findings of FHS

1. **Physical output is negatively correlated with output price, which implies that establishments are facing a downward demand curve.**
2. **Variances of physical TFP (TFPQ) are larger than those of traditional TFP. Like traditional TFP, the differences between firms are persistent.**
3. **TFPQ of entry firms are higher than that of incumbent firms. Demand decrease will lead to a greater exit probability.**
4. **Decomposition analysis following Foster , Haltiwanger, Krizan (2001) shows that net entry effect using TFPQ is greater than such effect using traditional TFP.**

1. Introduction

- **Previous studies in Japan (Nishimura, et, al (2005) and Fukao and Kwon (2006), survey made by Fukao, Kwon and Kim (2008) as well as Ito and Matsuura(2011)):**
- **There are productivity differences between firms. However, the contribution of net entry effect is small. The contribution of productivity improvement within a firm to productivity growth at the aggregate level is greater.**

Decomposition of productivity grwoth (manufacuring, establishment level)

(%)

	TFP growth	Rate of contirbution			
		Within effect	Reallocation effect		Net entry effect
			Share effect	Covariance effe	
1981-90	1.81	65	-8	15	27
1990-2000	1.12	49	-7	31	24

Source: Ito and Matsuura (2011)

1. Introduction

Our analysis:

Following FHS, we construct TFPQ using data from the Census of Manufacturers in Japan. We identify the effect of demand side by using TFPQ. Also, we compare TFPQ with traditional TFP measures in conducting entry and exit analysis.

Summary of our findings:

1. **Similar to FHS, there is a negative correlation between physical output and output prices. This implies that establishments face downward demand curve.**

1. Introduction

2. **Variances of physical TFP (TFPQ) are larger than those of traditional TFP measures. The persistence of differences in TFPQ between firms is also confirmed.**
3. **Though TFPQ of entry firms is not necessarily higher than that of incumbents, younger firms show learning-by-doing effects in which productivity improves after market-entry (consistent with Kawakami and Miyagawa (2008)). Decrease in demand factors leads to higher exit probability.**
4. **The decomposition using TFPQ shows that net entry effect is larger and "within effect" is smaller. The results are in contrast to previous studies in Japan.**

2. Data Construction and Three Measures of TFP

- **We choose 12 products for our study; “Rice wine called ‘sake’ including unrefined”, “Semi-finished green tea”, “Miscellaneous yarn-dyed narrow silk fabrics”, “Women's and girls’ knitted sweaters, cardigans and vests ”, “Socks”, “Flexible plastic film for packaging, less than 0.2 mm thickness”, “Women's and children's leather footwear”, “Fresh concrete”, “Smoked roofing tile”, “Iron castings for machinery”, “Iron wire gauze, including welded wire gauze and wire-cylinders”, “Tatami (Straw-mats and mat bases)”. We take the data of gross output, labor inputs, material inputs and capital stock. Prices are obtained by dividing shipment values by physical output. (N=28941)**
- **Criteria for our product choices are: selected goods should be homogenous and be mostly produced by single-products firms.**

2. Data Construction and Three Measures of TFP

Three kinds of TFP

- **TFPT: Measured by the way closest to the traditional method. Shipment value (revenue) of each establishment is deflated by price deflator at the industry level taken from JIP database (productivity database at the industry level in Japan).**
- **TFPR: Shipment value of each establishment is deflated by the product price, which is the revenue-weighted mean of product price for each establishment.**
- **TFPQ: Uses physical output taken from Census of Manufacturers**

3. Characteristics of TFPQ

- **Table 1: Variances of TFPQ are much larger than those of TFPT and TFPR.**

  → Differences in technological efficiency between firms are greater than expected.
- **Product price movement mitigates variances of traditional TFP measures.**

Table 1. Summary Statistics

5 Socks	Obs	Mean	Variance
TFPT	831	0.36	0.27
TFPR	831	0.46	0.28
TFPQ	831	-2.51	0.43
lnPrice	831	2.89	0.19

10 Iron castings for machinery	Obs	Mean	Variance
TFPT	2781	0.24	0.12
TFPR	2781	0.45	0.12
TFPQ	2781	-2.68	0.24
lnPrice	2781	3.08	0.10

3. Characteristics of TFPQ

- **Table 2: Persistence of TFP differences is confirmed by autoregressive regressions**
- **Table 3: Each TFP measure is positively correlated with each output measure.**

  Among correlations between output measure and product price, only physical output is negatively correlated.

  →TFPQ is negatively correlated with product price, while other TFP measures show positive correlations.

Table 2. Persistence of Productivity, Price and Demand Shock
Weighted regression

Dependent Variable	Five-Year Horizon		Implied One Year Persistence Rate
	Coef.	Std. Err	
Traditional TFP	0.700	0.000	0.931
Revenue TFP	0.715	0.000	0.935
Physical TFP	0.963	0.000	0.992
lnPrice	0.971	0.000	0.994

Table 3. Correlations for Output, Price, and Productivity Measures

	Traditional Output	Revenue Output	Physical Output	Traditional TFP	Revenue TFP	Physical TFP	lnPrice
Traditional Output	1						
Revenue Output	0.991 ***	1					
Physical Output	0.9191 ***	0.9046 ***	1				
Traditional TFP(TFPT)	0.5862 ***	0.5577 ***	0.5369 ***	1			
Revenue TFP(TFPR)	0.5669 ***	0.5832 ***	0.5079 ***	0.9218 ***	1		
Physical TFP(TFPQ)	0.3562 ***	0.3253 ***	0.6147 ***	0.6721 ***	0.5855 ***	1	
lnPrice	0.0796 ***	0.1025 ***	-0.3176 ***	0.042 ***	0.0892 ***	-0.7018 ***	1

Notes: We remove product-year effects from each variable before computing the statistics. N=28941.
*** indicates statistical significance at 1%.

3. Characteristics of TFPQ

- **Table 4: Physical output is regressed by product price. Negative coefficients indicate that establishments face downward-sloping demand curves.**
- **Residuals are extracted and recognized as idiosyncratic demand factors.**
- **Correlations between the idiosyncratic demand factor and each TFP measure: The correlation between TFPQ and the demand factor is much smaller than that between TFPT or TFPR and the demand factor.→The results imply that TFPQ indicating pure technological efficiency is independent from the demand factor.**

Table 4. Estimating Price Elasticities by Products
IV Estimation

Products	Price Coefficient	Std. Err
1 Rice wine called 'sake' including unrefined	-4.51	0.14
2 Semi-finished green tea	-10.78	1.87
3 Miscellaneous yarn-dyed narrow silk fabrics	-1.57	0.05
4 Women's and girl's knitted sweaters, cardigans and vests	-1.87	0.06
5 Socks	-3.93	0.27
6 Flexible plastic film for packaging, less than 0.2 mm thickness	-3.58	0.19
7 Women's and children's leather footwear	-3.53	0.24
8 Fresh concrete	-14.19	0.44
9 Smoked roofing tile	-1.73	0.07
10 Iron castings for machinery	-6.27	0.24
11 Iron wire gauze, including welded wire gauze and wire-cylinders	-3.99	0.18
12 Tatami (Straw-mats and mat bases)	-3.01	0.14

Instrumented: lnprice
Instruments: TFPQ

Table 5. Correlations between Productivity Measures and Demand Shock

	Traditional TFP(TFPT)	Revenue TFP(TFPR)	Physical TFP(TFPQ)	Demand Shock
Traditional TFP(TFPT)	1			
Revenue TFP(TFPR)	0.9196 ***	1		
Physical TFP(TFPQ)	0.2705 ***	0.2434 ***	1	
Demand Shock	0.2802 ***	0.3409 ***	0.0727 ***	1

Notes: *** indicates statistical significance at 1%.

We use our pooled sample of 28,941 plant-year observations.

4. Entry and Exit Behavior and TFP measures

- **How is TFP related to entry and exit behaviors?**

Equation (2)

$$f_{it} = \gamma_0 + \gamma_1 Exit_{it} + \gamma_2 Entry_{it} + \gamma_3 Young_{it} + \gamma_4 Old + \sum_{gt} \lambda INDYEAR_{gt} + \varepsilon_{it}$$

f **: each TFP measure, logarithm of output price, demand factor**

Exit**: exit dummy**

Entry**: entry dummy**

Young**: dummy variable where an establishment that appeared after 2000 is 1**

Old **: dummy variable for a firm operating from the year 1980 or 1985**

4. Entry and Exit Behavior and TFP measures

Estimation results (Table 6)

1. **All types of TFP of entry and exit firms are lower than those of incumbents.**
2. **However, TFP of firms that entered the market after 2000 is higher than that of incumbents (weighted regression weighted by revenue). This implies learning-by-doing effect in which newcomers are less productive at early stage but continue to improve in productivity after their entry, as shown in Kawakami and Miyagawa (2008).**

Table 6. Effects of Entry and Exit on Productivities

Unweighted Regressions

	TFPT		TFPR		TFPQ		lnPrice		Demand shock	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
Exit_dummy	-0.135	0.005	-0.125	0.005	-0.402	0.024	0.272	0.023	-0.523	0.029
Entry_dummy	-0.079	0.007	-0.069	0.007	-0.140	0.032	0.067	0.030	-0.398	0.038
Young	-0.001	0.014	-0.022	0.014	-0.041	0.063	0.028	0.060	-0.022	0.076
Old	-0.003	0.005	-0.001	0.005	-0.027	0.023	0.035	0.022	-0.090	0.028

Weighted Regressions

	TFPT		TFPR		TFPQ		lnPrice		Demand shock	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
Exit_dummy	-0.071	0.000	-0.067	0.000	-0.007	0.000	-0.067	0.000	-0.354	0.000
Entry_dummy	-0.088	0.000	-0.080	0.000	-0.162	0.000	0.077	0.000	-0.462	0.000
Young	0.116	0.000	0.087	0.000	0.080	0.000	0.025	0.000	0.190	0.000
Old	-0.014	0.000	0.010	0.000	0.176	0.000	-0.176	0.000	-0.040	0.000

Notes: The sample is our pooled sample of 28,941 plant-year observations.

Weighted regressions are weighted by revenue.

All regressions include a constant term and product-year interaction dummies.

4. Entry and Exit Behavior and TFP measures

Probit estimation of exit factors: Exit establishment 1, other 0.

- **The effects of TFPQ movements on marginal exit probability are lower than those of other TFP measures. However, in the joint estimations with product price and demand factors behind price movement, the effects of TFPQ on exit probability are greater.**
- **Lower price increases exit probability. In combination with demand factors, lower demand induces lower prices, which leads to higher exit probability.**

Table 7. Probit Estimation of Plant Exits

Unweighted Regressions

Specification	[1]		[2]		[3]		[4]		[5]		[6]		[7]	
	Coef	Std. Err	Coef	Std. Err	Coef	S.E.	Coef	Std. Err	Coef	Std. Err	Coef	Std. Err	Coef	Std. Err
Traditional TFP	-0.5475	0.0210												
Revenue TFP			-0.5139	0.0211										
Physical TFP					-0.0735	0.0044					-0.5258	0.0214	-0.0871	0.0049
lnPrice							0.0541	0.0047			-0.4875	0.0226		
Demand Shock									-0.0759	0.0046			-0.0795	0.0047

Weighted Regressions

Specification	[1]		[2]		[3]		[4]		[5]		[6]		[7]	
	Coef	Std. Err	Coef	Std. Err	Coef	S.E.	Coef	Std. Err	Coef	Std. Err	Coef	Std. Err	Coef	Std. Err
Traditional TFP	-0.4410	0.0001												
Revenue TFP			-0.4266	0.0001										
Physical TFP					-0.0138	0.0000					-0.4778	0.0001	-0.0290	0.0000
lnPrice							-0.0024	0.0000			-0.4702	0.0000		
Demand Shock									-0.0408	0.0000			-0.0457	0.0000

Notes: Dependent variables are Exit dummies.

Weighted regressions are weighted by revenue.

All regressions include a constant term and product-year interaction dummies.

4. Entry and Exit Behavior and TFP measures

- **Decomposition of aggregate TFP growth following Foster, Haltiwanger, and Krizan (2001).**

$$\Delta TFP_t = \sum_{i \in C} s_{it-k} \Delta tfp_{it} + \sum_{i \in C} (tfp_{it-1} - \overline{TFP}_{t-k}) \Delta s_{it} + \sum_{i \in C} \Delta tfp_{it} \Delta s_{it}$$
$$+ \sum_{i \in E} s_{it} (tfp_t - \overline{TFP}_{t-k}) + \sum_{i \in X} s_{it-k} (tfp_{it-k} - \overline{TFP}_{t-k})$$

- **Decomposition using TFPT or TFPR shows that contribution of net entry effect is negative as shown in previous studies.**
- **The decomposition using TFPQ shows that the positive contribution of net entry effect to the aggregate productivity growth is the largest factor and that of "within effect" is smaller.**

Table 8. Decomposition of Industry Productivity Growth
All products

		Components of Decomposition					
	Total growth	Within	Between	Cross	Entry	Exit	Net entry
TFPT	-0.010	-0.004	-0.002	0.009	-0.015	-0.001	-0.013
TFPR	-0.005	-0.001	-0.002	0.008	-0.012	-0.001	-0.011
TFPQ	0.025	-0.009	0.001	0.002	0.024	-0.007	0.031

5. Concluding Remarks

Our study:

Following FHS, we constructed TFPQ using data from the Census of Manufacturers. We identified characteristics of TFPQ and examined effects on entry and exit behavior.

Summary of findings

1. **Variances of TFPQ are much larger than those of TFPT and TFPR. Differences in technological efficiency between firms are greater than expected.**

5. Concluding Remarks

2. **Physical output is negatively correlated with product price, which implies that establishments face downward-sloping demand curves. In light of low correlation between TFPQ and the demand factor, pure technological efficiency is independent from the demand factor. The traditional measures of TFP are mixed ones that include technological and demand effects.**
3. **All types of TFP measures of entry and exit firms are lower than those of incumbents. However, young firms improved productivity after market entry.**

5. Concluding Remarks

4. **In addition to TFP, demand factors should not be overlooked as factors affecting exit.**
5. **The decomposition using aggregate TFP shows that the contribution of "within effect" is smaller and that of net entry effect is the largest factor, in contrast to previous studies.**

Policy implications from this study

1. **The results provide clear foundations for policies in support of "creative destruction."**
2. **Appropriate demand allocation also affects "creative destruction mechanism."**

5. Concluding Remarks

The limitation of our study and challenges

1. **We focus on single-product establishments producing homogenous goods. Performances producing differentiated goods are more affected by demand factor as indicated by findings from previous studies.**
2. **Need for detailed analysis of demand factors.**

Thank you for your attention!