RIETI Discussion Paper Series 17-E-088

Dispersion and Volatility of TFPQ in Service Industries

MORIKAWA Masayuki
RIETI

Research Institute of Economy, Trade & Industry, IAA
The Research Institute of Economy, Trade and Industry
http://www.rieti.go.jp/en/

RIETI Discussion Paper Series 17-E-088

June 2017

Dispersion and Volatility of TFPQ in Service Industries*

MORIKAWA Masayuki (RIETI)

Abstract

This study, using microdata on narrowly-defined service industries, presents empirical findings on the cross-sectional dispersion and time-series volatility of total factor productivity (TFP). The novelty of this study lies in its use of high-frequency, establishment-level panel data to compare the physical measure of productivity (TFPQ) and revenue-based productivity (TFPR) in the service industries. According to the analysis, first, TFPQ and TFPR are highly correlated with each other in terms of cross-section as well as time-series dimensions. Second, the within-industry dispersion of TFPQ is not necessarily larger than that of TFPR, which differs from past studies on the manufacturing sector. Third, TFPQ dispersion is lower when aggregated industry-level TFPQ is higher, and vice versa. Fourth, service producers with highly volatile TFP are less productive.

Keywords: Service industry, TFP, Dispersion, Volatility

JEL Classifications: D24, L83, L84

RIETI Discussion Papers Series aims at widely disseminating research results in the form of professional papers, thereby stimulating lively discussion. The views expressed in the papers are solely those of the author(s), and do not present those of the Research Institute of Economy, Trade and Industry.

*I would like to thank Shota Araki, Kenta Ikeuchi, Yoko Konishi, and the seminar participants at RIETI for their helpful comments and suggestions. Any errors are my own. I am grateful to the Ministry of Economy, Trade, and Industry for providing the microdata of the Current Survey of Selected Service Industries used in this study. This research is supported by the JSPS Grants-in-Aid for Scientific Research (26285063, 16H06322).

Dispersion and Volatility of TFPQ in Service Industries

1. Introduction

Under the declining potential growth rate, improving productivity growth in the service sector is an important policy issue in advanced economies, including Japan. However, empirical analyses on the productivity of service sector have been lagging far behind those on the manufacturing sector where rich statistical data are available. Especially, productivity studies on the service industries using establishment-level panel data have been scarce.

It is well-known that within-industry dispersion of productivity across producers is large and that dynamic reallocation of production potentially contributes to the productivity performance at the aggregate level (Bartelsman and Doms, 2000; Syverson, 2011; Haltiwanger, 2015, for surveys). Furthermore, the reallocation effects are suggested to play a more important role than the productivity growth of individual producers ("within effects") in the service industry (Foster *et al*., 2006, for the U.S. retail industry).

In addition to the cross-sectional dispersion, since service industries generally have characteristics of "simultaneous production and consumption," time-series fluctuations of production greatly affect the performance of service producers. However, in order to conduct a detailed analysis on volatility, using high-frequency (monthly or quarterly) data is essential. In this respect, empirical study on the distribution and movement of productivity in the service industries at the micro level is necessary in planning effective policies to improve productivity.

Based on these motivations, this study presents new findings on the cross-sectional dispersion and time-series volatility of three narrowly-defined service industries. Specifically, this study, using establishment-level panel data for about 16 years taken from the Current Survey of Selected Service Industries (conducted by the Ministry of Economy, Trade and Industry: METI), a monthly official statistical survey, documents the following: (1) comparisons of quantity- and revenue-based measures of total factor productivity (denoted as TFPQ and TFPR), (2) the relationship between the dispersion of TFP and the industry mean TFP level, and (3) the relationship between the volatility of TFP and the mean productivity of the establishments.

This study greatly extends the analyses of Morikawa (2011, 2012), which present evidence on the productivity of service industries in Japan using cross-sectional data from annual statistics of the Survey of Selected Service Industries (METI), in particular the time-series dimension available from the Current Survey of Selected Service Industries. This is the first study to analyze TFPQ and TFPR of the service industries based on establishment-level monthly panel data.

To preview the major results of this study, first, TFPQ and TFPR are highly correlated with each other, which means that establishments of higher physical productivity are also productive in terms of revenue. Second, within-industry dispersion of TFPQ among establishments is not larger than that of TFPR. This finding is different from past studies on the manufacturing sector and suggests that unit price of the physically productive establishments tends to be higher than the less productive ones. Third, dispersion of TFPQ is smaller when aggregated industry-level TFPQ is higher, and vice versa. Fourth, service producers with highly volatile productivity are less productive in both TFPQ and TFPR.

The rest of this paper is structured as follows. Section 2 briefly reviews the literature and explains the contribution of this study. Section 3 explains the data used in this study and the method of analysis. Section 4 reports and interprets the results, and Section 5 concludes with implications.

2. Literature Review

It is sort of a stylized fact in empirical research on industrial organizations that there is large dispersion of productivity across establishments or firms in the same industry (Bartelsman and Doms, 2000; Syverson, 2011, for surveys). Parallel with this finding, a large number of studies have been conducted on the mechanism behind the large dispersion of measured productivity, as well as on the characteristics of productive establishments/firms.[1] However, Foster *et al*. (2016b) point out that the dispersion of productivity depends on the method of measurement and caution in interpreting the measured dispersion of revenue-based productivity (TFPR).

Although studies on the productivity dispersion of service industries have been scarce relative

[1] One possible reason behind the large productivity dispersion is the mismeasurements of productivity due to data limitation. Fox and Smeets (2011), White *et al*. (2012), Ataley (2014), and Bartelsman, *et al*. (2015) are the studies dealing with the role of measurement errors. Among these studies, Fox and Smeets (2011) and Bartelsman, *et al*. (2015) investigate the effects of labor quality; Ataley (2014) analyzes the effects of price of intermediate inputs; and White *et al*. (2012) consider the effects of imputation for missing values.

to those of manufacturing industries, Kremp and Mairesse (1992) on French service industries, Oulton (1998) and Faggio *et al.* (2010) on both manufacturing and non-manufacturing industries in the United Kingdom, and Chandra, *et al*. (2016) on medical service (hospitals) in the United States are a few examples of such analyses. Oulton (1998) and Faggio *et al.* (2010) indicate that productivity dispersion in the service industries is greater than that of manufacturers. In contrast, Chandra *et al*. (2016) find that productivity dispersion across hospitals in treating heart attacks is slightly smaller than the productivity dispersion within narrowly-defined manufacturing industries in the United States. In Japan, Ito and Lechevalier (2009) use firm-level data covering manufacturing, wholesale, and retail industries, and indicate that the dispersion of TFP increased, particularly among manufacturing firms.[2]

Regarding the cross-sectional relationship between the dispersion of productivity and the industry-aggregated productivity level, past studies on the manufacturing sector indicate that industries with strong market competition tend to show smaller dispersion of productivity and higher mean productivity level (Syverson, 2004a, b). However, such a study has not yet been done on the service industries.

Studies on the dispersion of productivity over business cycles have presented mixed results. For example, Kehrig (2011) indicates that the dispersion of TFP in durable manufacturing industries in the United States is small during booms and large in recessions. In contrast, Escribano and Stucchi (2014), using data for Spanish manufacturing firms, find that productivity tends to converge in recessions. However, the cyclical properties of establishment- or firm-level TFP in the service sector has not been studied so far, to the best of the author's knowledge.

From the viewpoint of macroeconomics, there have been a number of studies on the time-series volatility of sales or employment of establishments or firms (see Davis and Kahn, 2008, for a survey), but studies on the volatility of productivity have been scarce.[3] Exceptionally, Chun *et al*. (2011) analyze the volatility of TFP growth among public firms in the United States and show that firm-level TFP growth volatility rose until 2000 and then reverted. However, their study is limited to public firms and the data used is annual frequency. As far as the author is aware, analysis on the volatility of TFP at a monthly frequency has not yet been conducted.

---

[2] According to Ito and Lechevalier (2009), the introduction of information and communication technologies (ICT) decreased the within-industry productivity dispersion, but internationalization has had a significant and positive impact on productivity dispersion.

[3] Empirical studies on the volatility of Japanese firms include Kim and Kwon (2012) and Oikawa (2013); however, these studies do not deal with the volatility of productivity.

The distinction of physical measure of TFP (TFPQ) and revenue-based TFP (TFPR) has been attracting attention since the pioneering work by Foster *et al*. (2008). In order to measure TFPQ, data on physical measure of outputs is necessary, and the analysis should focus on finely disaggregated industries. In this respect, Foster *et al*. (2008) use establishment-level data on narrowly-defined 11 manufacturing products in the United States (e.g., solid fiber boxes, carbon black, ready-mixed concrete, and motor gasoline) and document that the dispersion of TFPQ is greater than the dispersion of TFPR. They further indicate that the TFPQ and TFPR are highly correlated with each other, and TFPQ is negatively correlated with establishment-level prices while TFPR is positively correlated with prices. In other words, plants with higher TFPQ have lower marginal costs and charge lower prices. Other papers analyzing TFPQ of manufacturing plants include Ataley (2014), Carlsson *et al*. (2016), and Foster *et al*. (2016a).

Studies on TFPQ of the Japanese manufacturing sector include Kawakami *et al*. (2011) and Braguinsky, *et al*. (2015). Kawakami *et al*. (2011) conduct a similar analysis using plant-level data from the Census of Manufacturers (METI) and confirm the findings of Foster *et al*. (2008) that TFPQ is more dispersed across plants than TFPR. Braguinsky, *et al*. (2015), using data on the Japanese cotton spinning industry before the Second World War, measure plant-level TFPQ and indicate that M&A contributed to the industry's productivity growth. However, the subjects of these studies are confined to the manufacturing sector, and data used in these studies are of annual frequency.

To summarize, the TFPQ based upon the physical output measure provides opportunities to obtain a variety of new knowledge about productivity. However, mainly due to data limitation, studies on TFPQ in the service industries have been very scarce. Exceptionally, the aforementioned work by Chandra *et al*. (2016), which uses survival rate of patients as a measure of hospital output and estimates TFP as the coefficient on a set of hospital-year fixed effects, can be regarded as an analysis of TFPQ in the service sector. Morikawa (2011) is one of the rare studies measuring TFPQ in the Japanese personal service industries, but the analyses depend on the annual cross-sectional data. The novelty of the present paper lies in its use of monthly-frequency establishment-level panel data to uncover the time-series properties of TFPQ and TFPR, as well as their cross-sectional dispersion, in the narrowly-defined service industries.

3. Data and Methodology

This study uses monthly establishment-level panel data from the Current Survey of Selected Service Industries for the period between January 2000 and June 2015. The Current Survey of Selected Service Industries was initiated in 1987 to collect information on three business service industries: the leasing industry, information services industry, and advertising agencies. The coverage of service industries has gradually expanded since then, and 19 industries fell under the purview of surveys at the time of the analysis in this paper. Because of the purpose to collect information on monthly fluctuations of business activities, the survey is on sampled establishments (or firms). However, since the same establishments (or firms) are surveyed continuously, it is possible to construct a panel data set. [4]

Although the survey items are limited and vary according to individual industries, the number of employees (and the number of full-time and part-time employees as the subsets) and monthly sales (thousand yen) are surveyed as common items across industries. Although the value of tangible assets is not surveyed, some industries have good proxies of physical capital stock such as the number of holes in golf courses and the number of boxes in golf driving ranges. Furthermore, quantity-based output measures such as the number of total users are available in seven industries.

The present study focuses on the three service industries in which the physical measures of output and proxies of capital stock, both of them necessary to calculate TFPQ, are available. Specifically, movie theaters, golf courses, and golf driving ranges are the object industries of this study.[5] **Table 1** summarizes the outline of these industries. The unit of the Current Survey of Selected Service Industries is an establishment or firm depending on the individual industries, but the unit of these three industries is establishment. The period of analysis is about 16 years from January 2000, when these amusement services were first covered by the survey, to June 2015. However, the sample period of movie theaters is limited from January 2002 to December 2012, because the number of seats was not added as a survey item before 2002 and the unit of the survey was changed from an establishment to a firm in 2013.

TFPQ and TFPR are calculated as the residuals of simple Cobb-Douglas production functions estimated by industry, similar to Morikawa (2011, 2012). The whole establishment-month observations are pooled in the estimations. Both outputs and inputs are expressed in logarithmic

[4] Since some of the surveyed establishments have been replaced during the sample period, the data set is an unbalanced panel.
[5] In addition to these three service industries, proxy of capital stock is available in the pinball parlor industry, but physical output measure is not surveyed in this industry.

forms. Output (Y_{it}) is the quantity of monthly production for TFPQ or, alternatively, the monthly sales for TFPR. Production quantities in these industries are the total number of users in each month. The value of monthly sales is the one generated from the specific services of interest (not the entire sales of the establishment). The value of monthly sales is adjusted for general inflation deflated by the consumer price index (Ministry of Internal Affairs and Communications). In order to adjust the different number of days by months, the monthly outputs are converted into daily figures. For example, output in March is divided by 31 and that of April is divided by 30.[6] Since the Current Survey of Selected Service Industries does not have information about the amount of intermediate inputs, the physical and revenue outputs are taken as the gross measures.

The factors of production are capital (K_{it}) and labor (L_{it}). The proxy variables of physical capital stock are the number of seats (movie theaters), the number of holes (golf courses), and the number of boxes (golf driving ranges).[7] The number of employees is not the establishments' total employees but those who engaged in the specific services, which is consistent with the output measures explained above, enabling us to estimate the production functions of narrowly-defined service activities accurately. Since the separate figures of full-time and part-time employees are available, in order to adjust different working hours of these two types of employees, the ratio of part-time workers (*part-time*) is included as a control variable.

To summarize, the equation to be estimated is expressed as follows.

$$\ln Y_{it} = ß_0 + ß_1 \ln K_{it} + ß_2 \ln L_{it} + ß_3 \, part\text{-}time + \varepsilon \quad (1)$$

After calculating the TFPQ and TFPR as the residuals obtained from the estimated production functions, we first observe and compare the time-series movements of TFPQ and TFPR. Then, we calculate the correlation coefficients between the two TFP measures and the cross-sectional dispersion (standard deviations) of both TFP measures. Next, we analyze the relationship between the dispersion of TFP and the industry-aggregated TFP levels. Our interest is whether the dispersion of productivity is greater or smaller when industry-level productivity is higher or lower. Lastly, we analyze the relationship between the time-series volatility (standard

---

6 Monthly output in the February month of a leap year is divided by 29.

7 In this estimation, capital utilization rate is not controlled, which means that the estimated TFPs necessarily reflect changes in capacity utilization. However, removing the effect of capacity utilization will ignore one of the most important elements in analyzing service sector productivity, where "simultaneous production and consumption" is inevitable.

deviation) of productivity and the mean level of productivity of the establishments. The purpose is to test whether the mean productivity level of the establishment with highly volatile (less volatile) productivity is lower (higher) or not.

4. Results

The production function estimation results by industry are presented in **Appendix Table A1**. Using the estimated establishment-level TFPs as the residuals of the production functions, we first calculate the annualized productivity growth rates as the coefficients on time trend by ordinary least square (OLS) estimations, which are reported in **Table 2**.[8] With an exception of golf driving ranges, the measured productivity growth rates are negative for TFPQ and TFPR. For all three industries, the growth rate of TFPR is lower than that of TFPQ, indicating the trend decline in unit prices (adjusted for macroeconomic inflation rate) of these services.

Next, we calculate correlation coefficients between the TFPQ and TFPR (**Table 3**). The coefficients calculated from all observations are 0.917 for movie theaters, 0.827 for golf courses, and 0.737 for golf driving ranges (column (1)). However, these simple correlations reflect both cross-establishment and time-series dimensions. Establishment-level cross-sectional correlations reported in column (2) are calculated using the mean TFPQ and TFPR of each establishment throughout the sample period. All the correlation coefficients exceed 0.9, indicating that establishments with high TFPQ are also productive in terms of TFPR. On the other hand, time-series correlations reported in column (3) are calculated using the industries' mean TFPQ and TFPR for the sample establishments in each month. While the size of the figures is different by industry, the two industry-level productivity measures are also highly correlated.

The positive cross-sectional correlation coefficients themselves are not surprising, but the figures are larger than the figure for the U.S. manufacturing industry reported by Foster *et al.* (2008). Regarding the time-series positive correlations, our interpretation is as follows. Since the short-term movements of production in the service industries, which do not have inventory, directly reflect the demand fluctuations, the total sales must be highly correlated with the production quantity. In addition, in times of stronger demand, service firms may be able to charge

[8] In the OLS estimations, in addition to the time trend, a set of month dummies are included as the explanatory variables to control seasonal effects.

higher prices.

The within-industry dispersions of productivity averaged through the sample period are reported in **Table 4**.[9] Although the dispersions of TFPQ and TFPR are quantitatively not much different in the movie theaters, the dispersion of TFPQ is smaller than that of TFPR in the golf courses and golf driving ranges. Foster *et al*. (2008) indicate that the within-industry dispersion of TFPQ is larger than that of TFPR, and TFPQ is inversely and TFPR is positively correlated with the product prices (i.e., physically productive plants charge lower prices) in the manufacturing industries in the United States. Kawakami *et al*. (2011) report a similar result for the Japanese plants in 12 manufacturing industries.[10] With the exception of movie theaters, the results for the service industries are different from the findings of past studies on the manufacturing industry. We conjecture that physically more productive establishments tend to charge higher service prices by supplying high-quality differentiated services.

In order to observe the time-series relationships between the within-industry productivity dispersion and the industry average productivity, **Table 5** indicates the comparison of the mean TFP levels by splitting the months into more and less dispersed periods relative to the median value. With an exception of TFPR of movie theaters, dispersions are generally larger when industry average productivity is lower, and vice versa. To express in percentage terms, the gaps of industry average level of TFPQ are +17.3% points for movie theaters, +39.6% points for golf courses, and +16.8% points for golf driving ranges. The gaps of TFPR are -15.0% points, +40.7% points, and 12.5% points, respectively.[11] The simple averages of the gaps of the three industries are +24.6% points for TFPQ and +15.9% points for TFPR. Although the reason behind the different result for the TFPR of movie theaters is difficult to determine, we conjecture that more productive establishments flexibly change their pricing in response to the demand fluctuations. For example, productive theaters reduce the unit price by applying discounts to attract customers when demand is weak. While inconclusive, the result suggests that when the industry-level TFP is low, less productive establishments' TFP tends to decline disproportionally, and vice versa.

---

[9] The sizes of the within-industry dispersion of productivity do not indicate upward or downward trends.

[10] According to Kawakami *et al*. (2011), the dispersion of productivity in the Japanese manufacturing plants—the simple averages of standard deviations in the 12 industries examined—are 0.67 for TFPQ and 0.45 for TFPR (we have converted the variances reported in their study into standard deviations).

[11] When the industry average productivity is regressed on the within-industry dispersion of productivity, the estimated coefficients for dispersion are negative and significant in golf courses and golf driving ranges, but the coefficients are positive in movie theaters.

Lastly, we observe the cross-sectional relationship between the establishments' volatility and their period average TFP level. **Table 6** compares the average TFP levels of establishments by splitting the sample into establishments of volatile productivity and those of less volatile productivity relative to the median volatility establishment. It is obvious without exception that high volatility establishments exhibit lower average TFP levels. In percentage terms, the mean TFPQ of less volatile establishments relative to the high volatility ones is +4.0% points for movie theaters, +32.5% points for golf courses, and +8.9% points for golf driving ranges. The gaps of TFPR are +7.6% points, +33.9% points, and +9.0% points, respectively. The simple averages of the gaps are +15.1% points for TFPQ and +15.8% points for TFPR.[12]

In addition to the comparisons by splitting the sample establishments by the median volatility, we run simple regressions to explain the period average TFP by the volatility. The coefficients for volatility are negative and significant at the 1% level in all three industries, both for TFPQ and TFPR (**Appendix Table A2**). Based on the regression results, one standard deviation of greater volatility is associated with about 5% to 15% lower productivity.

Taken together, these results indicate that during the periods when industry average productivity (or aggregated production) is relatively low, the productivity performance of individual establishments diverges, resulting in the negative association between the volatility of productivity and the period average productivity at the establishment level. The implication is that it is important for service establishments to maintain productivity at times when demand is weak. In other words, smoothing demand is an effective strategy to improve productivity performance in the service industries.

5. Concluding Remarks

This study, using establishment-level monthly panel data from the Current Survey of Selected Service Industries, documents empirical evidence on the cross-sectional dispersion and the time-series volatility of productivity in the three narrowly-defined service industries. The novelty of this study lies in its use of high-frequency, time-series microdata to compare the TFPQ and TFPR in service industries. The major results of this study and the implications are summarized as

[12] The negative association between the volatility and productivity is consistent with Morikawa (2012).

follows.

First, TFPQ and TFPR are highly correlated with each other both for the cross-section of establishments and for the time-series movements, which means that establishments of higher physical productivity are also productive in revenue and that physically productive periods are profitable on average. The correlations are stronger than the figures for the U.S. manufacturing industry reported by Foster *et al*. (2008). The result of high correlations between TFPQ and TFPR suggests that a revenue-based measure can be used in analyzing productivity of service industries as an alternative to the physical measure.

Second, dispersion of TFPQ across establishments is not larger than that of TFPR, suggesting that the unit price of physically productive establishments tends to be higher than the less productive counterparts. This finding is different from past studies on the manufacturing sector (Foster *et al*., 2008; Kawakami *et al*., 2011).

Third, within-industry dispersion of TFPQ is smaller when aggregated industry-level TFPQ is higher, and vice versa, although the results for TFPR are different by industry and inconclusive.

Lastly, service producers with highly volatile TFP are less productive in both TFPQ and TFPR. This result suggests that due to the adjustment costs of production factors, smoothing demand potentially has an important role in improving productivity performance in the service industries.

Although this study is unique in its use of high-frequency establishment-level panel data for the service industries, there are limitations. The most obvious limitation is the coverage of service industries analyzed: This study analyzes the productivity of only three narrowly-defined service industries. Whether the results can be generalized to other service industries is an open question. Another limitation is that we cannot analyze the productivity dynamics through entry and exit of establishments. In addition, since the gross outputs without deducting intermediate inputs are used in this study, the measured TFPs may not be ideal in this respect. We leave these issues for future research.

References

Atalay, Enghin (2014), "Materials Prices and Productivity," *Journal of the European Economic Association*, Vol. 12, No. 3, pp. 575-611.

Bartelsman, Eric J. and Mark Doms (2000), "Understanding Productivity: Lessons from Longitudinal Microdata," *Journal of Economic Literature*, Vol. 38, No. 3, pp. 569-594.

Bartelsman, Eric, Sabien Dobbelaere, and Bettina Peters (2015), "Allocation of Human Capital and Innovation at the Frontier: Firm-Level Evidence on Germany and the Netherlands," *Industrial and Corporate Change*, Vol. 24, No. 5, pp. 875-949.

Braguinsky, Serguey, Atsushi Ohyama, Tetsuji Okazaki, and Chad Syverson (2015), "Acquisitions, Productivity, and Profitability: Evidence from the Japanese Cotton Spinning Industry," *American Economic Review*, Vol. 105, No. 7, pp. 2086-2119.

Carlsson, Mikael, Julian Messina, and Oskar Nordstrom Skans (2016), "Wage Adjustment and Productivity Shocks," *Economic Journal*, Vol. 126, September, pp. 1739-1773.

Chandra, Amitabh, Amy Finkelstein, Adam Sacarny, and Chad Syverson (2016), "Productivity Dispersion in Medicine and Manufacturing," *American Economic Review*, Vol. 106, No. 5, pp. 99-103.

Chun, Hyunbae, Jung-Wook Kim, and Randall Morck (2011), "Varying Heterogeneity among U.S. Firms: Facts and Implications," *Review of Economics and Statistics*, Vol. 93, No. 3, pp. 1034-1052.

Davis, Steven J. and James A. Kahn (2008), "Interpreting the Great Moderation: Changes in the Volatility of Economic Activity at the Macro and Micro Levels," *Journal of Economic Perspectives*, Vol. 22, No. 4, pp. 155-180.

Escribano, Alvaro and Rodolfo Stucchi (2014), "Does Recession Drive Convergence in Firms' Productivity? Evidence from Spanish Manufacturing Firms," *Journal of Productivity Analysis*, Vol. 41, No. 3, pp. 339-349.

Faggio, Giulia, Kjell G.Salvanes, and John Van Reenen (2010), "The Evolution of Inequality in Productivity and Wages: Panel Data Evidence," *Industrial and Corporate Change*, Vol. 19, No. 6, pp. 1919-1951.

Foster, Lucia, John Haltiwanger, and C.J.Krizan (2006), "Market Selection, Reallocation, and Restructuring in the U.S. Retail Trade Sector in the 1990s," *Review of Economics and Statistics*, Vol. 88, No. 4, pp. 748-758.

Foster, Lucia, John Haltiwanger, and Chad Syverson (2008), “Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability?” *American Economic Review*, Vol. 98, No. 1, pp. 394-425.

Foster, Lucia, John Haltiwanger, and Chad Syverson (2016a), “The Slow Growth of New Plants: Learning about Demand?” *Economica*, Vol. 83, January, pp. 91-129.

Foster, Lucia, Cheryl Grim, John Haltiwanger, and Zoltan Wolf (2016b), “Firm-Level Dispersion in Productivity: Is the Devil in the Details?” *American Economic Review*, Vol. 106, No. 5, pp. 95-98.

Fox, Jeremy T. and Valérie Smeets (2011), “Does Input Quality Drive Measured Differences In Firm Productivity?” *International Economic Review*, Vol. 52, No. 4, pp. 961-989.

Escribano, Alvaro and Rodolfo Stucchi (2014), “Does Recession Drive Convergence in Firms’ Productivity? Evidence from Spanish Manufacturing Firms,” *Journal of Productivity Analysis*, Vol. 41, No. 3, pp. 339-349.

Haltiwanger, John (2015), “Job Creation, Job Destruction, and Productivity Growth: The Role of Young Businesses,” *Annual Review of Economics*, Vol. 7, pp. 341-358.

Ito, Keiko and Sébastien Lechevalier (2009), “The Evolution of the Productivity Dispersion of Firms: A Reevaluation of its Determinants in the Case of Japan,” *Review of World Economics*, Vol. 145, No. 3, pp. 405-429.

Kawakami, Atsushi, Tsutomu Miyagawa, and Miho Takizawa (2011), “Revisiting Productivity Differences and Firm Turnover: Evidence from Product-Based TFP Measures in the Japanese Manufacturing Industries,” RIETI Discussion Paper, 11-E-064.

Kehrig, Matthias (2011), “The Cyclicality of Productivity Dispersion,” CES Working Paper, No. 11-15.

Kim, YoungGak, and Hyeog Ug Kwon (2012), “Aggregate and Firm-Level Volatility in the Japanese Economy,” RIETI Discussion Paper, 12-E-030.

Kremp, Elizabeth and Jacques Mairesse (1992), “Dispersion and Heterogeneity of Firm Performance in Nine French Service Industries, 1984-1987,” in Zvi Griliches ed. *Output Measurement in the Service Sectors*, Chicago and London: The University of Chicago Press, pp. 461-489.

Morikawa, Masayuki (2011), “Economies of Density and Productivity in Service Industries: An Analysis of Personal Service Industries Based on Establishment-Level Data,” *Review of Economics and Statistics*, Vol. 93, No. 1, pp. 179-192.

Morikawa, Masayuki (2012), “Demand Fluctuations and Productivity of Service Industries,” *Economics Letters*, Vol. 117, No. 1, pp. 256-258.

Oikawa, Koki (2013), “Cyclical Behavior of Firm-Level Volatility: An Explanation for the Contrast between the United States and Japan,” *Journal of Macroeconomics*, Vol. 38B, December, pp. 452-464.

Oulton, Nicholas (1998), “Competition and the Dispersion of Labour Productivity amongst UK Companies,” *Oxford Economic Papers*, Vol. 50, No. 1, pp. 23-38.

Syverson, Chad (2004a), “Product Substitutability and Productivity Dispersion,” *Review of Economics and Statistics*, Vol. 86, No. 2, pp. 534-550.

Syverson, Chad (2004b), “Market Structure and Productivity: A Concrete Example,” *Journal of Political Economy*, Vol. 112, No. 6, pp. 1181-1222.

Syverson, Chad (2011), “What Determines Productivity?” *Journal of Economic Literature*, Vol. 49, No. 2, pp. 326-365.

White, T. Kirk, Jerome P. Reiter, and Amil Petrin (2012), “Plant-level Productivity and Imputation of Missing Data in U.S. Census Manufacturing Data,” NBER Working Paper, No. 17816.

Table 1 Outline of the Service Industries Analyzed

Industry	(1) Sample period	(2) Measures of physical output	(3) Proxies of capital stock	(4) Number of observations	(5) Total sales in 2012 (billion yen)
Movie theaters	Jan 2002-Dec 2012	Number of total monthly users	Number of seats	36,035	154.621
Golf courses	Jan 2000-Dec 2015	Number of total monthly users	Number of holes	35,018	537.84
Golf driving ranges	Jan 2000-Dec 2015	Number of total monthly users	Number of boxes	34,416	163.041

Note: The total sales of the industries are taken from the Economic Census in 2012 (Ministry of Internal Affairs and Communications).

Table 2 Annual TFP Growth Rates

	TFPQ	TFPR
Movie theaters	-5.7% ***	-6.1% ***
Golf courses	-0.4% ***	-2.2% ***
Golf driving ranges	0.9% ***	0.0%

Note: The figures are annualized TFP growth rates calculated from the estimated coefficients for time trend, where TFPQ and TFPR are the dependent variables and month dummies are included to control seasonal effects. *** indicates that the estimated coefficient for time trend is statistically different from zero at the 1% significance level.

Table 3 Correlation Coefficients between TFPQ and TFPR

	(1) All observations	(2) Cross-section	(3) Time-series
Movie theaters	0.917	0.987	0.948
Golf courses	0.827	0.937	0.659
Golf driving ranges	0.737	0.935	0.732

Note: Column (1) is calculated using all pooled observations. Cross-sectional correlations reported in column (2) are calculated using the mean TFPQ and TFPR of each establishment throughout the sample period. Time-series correlations reported in column (3) are calculated using the industry average TFPQ and TFPR in each month.

Table 4 Within-Industry Dispersion of TFP

	TFPQ	TFPR	
Movie theaters	0.620	0.580	***
Golf courses	0.469	0.578	***
Golf driving ranges	0.375	0.505	***

Note: The figures are calculated as the period averages of the standard deviations in each month. *** indicates statistically significant difference between TFPQ and TFPR at the 1% level.

Table 5 Relationship between Dispersion and Mean Level of TFPs

	(1) TFPQ				(2) TFPR			
	Large dispersion months	Small dispersion months	Diff.		Large dispersion months	Small dispersion months	Diff.	
Movie theaters	-0.092	0.068	0.160	***	0.069	-0.093	-0.162	***
Golf courses	-0.191	0.142	0.334	***	-0.196	0.146	0.342	***
Golf driving ranges	-0.080	0.075	0.156	***	-0.059	0.059	0.118	***

Notes: This table indicates the comparison of the mean TFP levels by splitting the months into periods of large and small productivity dispersion relative to the median value in the sample period. *** indicates statistically significant difference at the 1% level.

Table 6 Relationship between Volatility and Mean TFP Level

	(1) TFPQ				(2) TFPR			
	High volatility establishments	Low volatility establishmeents	Diff.		High volatility establishments	Low volatility establishmeents	Diff.	
Movie theaters	0.005	0.044	0.039	***	-0.014	0.059	0.074	***
Golf courses	-0.155	0.127	0.282	***	-0.168	0.124	0.292	***
Golf driving ranges	-0.048	0.037	0.085	***	-0.060	0.026	0.087	***

Notes: The comparison of the mean TFP levels by splitting the establishments into high and low volatility ones relative to the median value. *** indicates statistically significant difference at the 1% level.

Appendix Table A1 Production Functions – Estimation Results

A. Quantity-Based Production Functions

	(1) Movie theaters		(2) Golf courses		(3) Golf driving ranges	
ln*K*	0.4584	***	0.6616	***	0.7406	***
	(0.0087)		(0.0122)		(0.0059)	
ln*L*	0.7156	***	0.2449	***	0.4131	***
	(0.0095)		(0.0068)		(0.0048)	
Part-time	0.1194	***	0.1408	***	-0.1363	***
	(0.0385)		(0.0129)		(0.0120)	
Constant	0.7106	***	1.7217	***	1.2384	***
	(0.0433)		(0.0363)		(0.0230)	
Nobs.	31,037		35,018		34,416	
Ajdusted-R^2	0.6787		0.1683		0.5779	

B. Revenue-Based Production Functions

	(1) Movie theaters		(2) Golf courses		(3) Golf driving ranges	
ln*K*	0.4364	***	0.2830	***	0.6817	***
	(0.0084)		(0.0148)		(0.0076)	
ln*L*	0.8179	***	0.6369	***	0.6949	***
	(0.0092)		(0.0083)		(0.0062)	
Part-time	0.0392		-0.1940	***	-0.5279	***
	(0.0369)		(0.0156)		(0.0155)	
Constant	-5.9384	***	1.6307	***	-0.9076	***
	(0.0416)		(0.0440)		(0.0297)	
Nobs.	30,960		35,017		34,415	
Ajdusted-R^2	0.7202		0.1999		0.5479	

Notes: OLS estimation results of the Cobb-Douglas production function with standard errors in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Panels A and B use physical outputs and sales as dependent variables, respectively. The variable *part-time* is the ratio of part-time employees.

Appendix Table A2 Volatility and Mean TFP Level

	(1) TFPQ		(2) TFPR	
Movie theater	-0.5940	***	-0.8090	***
	(0.0119)		(0.0136)	
Golf course	-0.6421	***	-0.6924	***
	(0.0052)		(0.0071)	
Golf driving range	-0.5683	***	-0.3770	***
	(0.0157)		(0.0198)	

Notes: OLS estimations where the period average TFP of establishments is the dependent variable and the volatility of the TFP is the explanatory variable. Standard errors are in parentheses. **** indicates statistical significance at the 1% level.