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Demand Fluctuations and Productivity of Service Industries

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Abstract

The purpose of this paper is to investigate empirically the relationship between demand fluctuations and productivity of service industries. Specifically, by using unique establishment-level data on service industries in Japan, this paper estimates production functions for six narrowly defined personal-service industries. In almost all the examined service industries, statistically and economically significant negative effects of demand variation on establishment-level productivity are found. This result suggests dispersing holidays may have positive effects on the productivity of service industries.

Keywords: Service Industry, Productivity, Demand Fluctuation, Paid Leave
JEL Classification: D24; L83; L84

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Demand Fluctuations and Productivity of Service Industries

1. Introduction

Recent studies stress the importance of service industries on a country's economic growth performance. Amid a decreasing labor force due to population aging, productivity growth of industries, especially service industries, is a focus of economic policy in Japan. Recently, the Service Productivity and Innovation for Growth (SPRING) ― a business-government-academia forum ― and the Service Engineering Research Center were established to enhance service sector innovation and productivity. However, analysis of productivity in service industries using microdata lags far behind that of the manufacturing industry, for which solid and reliable data are available.

The purpose of this paper is to document evidence on the relationship between short-term demand fluctuations and the total factor productivity (TFP) of service industries. Specifically, by using unique establishment-level data on six personal-service industries, in which the simultaneity of production and consumption is especially prominent, this paper estimates production functions for narrowly defined service industries in Japan.[1]

In many personal-service industries including restaurants, hotels, passenger transportation, and amusement services, demand fluctuates daily, weekly, and seasonally. On the other hand, capital and labor inputs cannot be adjusted immediately. As a result, service industries' productivity is heavily affected by short-term fluctuations in demand because the output cannot be stored. This is different from the manufacturing industry, where inventory can be used as a buffer to smooth production.

Several time-series analyses have shown that the relationship between measured TFP and the business cycle is stronger for service industries (Basu et al., 2006; Inklaar, 2007; Kawamoto, 2005; Miyagawa et al., 2006). This issue is closely related to the adjustment costs of labor and capital, as many studies have indicated significant factor adjustment costs and their negative

[1] Morikawa (2008) uses the same data to analyze the effects of spatial demand density on the productivity of service industries. The result indicates significant economy of demand density.

effects on productivity (see, for example, Hamermesh and Pfann, 1996; Groth, 2008). Although it is somewhat related to these studies, the focus of this paper is the effects of very short-term variability of demand on the establishment-level TFP.[2]

According to my analyses, significant negative effects of demand fluctuations on the establishment-level productivity are found in almost all the examined service industries. This result holds even if we use physical output measures that are not affected by price. The effects are quantitatively large: if demand varies by one standard deviation, the productivity of the establishment is on average 10% - 20% lower.

The rest of the paper proceeds as follows. In section 2, I describe the data and methods of analyses. Section 3 presents estimation results. Section 4 contains a brief conclusion.

2. Data and Method

This paper uses data on personal-service industries covered by the Survey of Selected Service Industries conducted by the Ministry of Economy, Trade and Industry (METI). This Survey, started in 1973, now covers more than twenty service industries. The sample covers all establishments operating in Japan. In this paper, I use recent (2001 or 2002) establishment-level data on six personal-service industries: movie theaters, golf courses, tennis courts, bowling alleys, fitness clubs, and golf driving ranges. The Survey asks establishments of these six industries about their ratio of users between weekdays, Saturdays, and Sundays. In addition, the number of users per month is also surveyed. This provides a good opportunity to assess the effects of short-term demand fluctuations on establishment-level productivity.

This paper estimates simple Cobb-Douglas production functions, augmented to account for measures of establishment-level demand fluctuations, as indicated below. The dependent variables are (i) value added and (ii) measures of physical output. Independent variables include labor, a proxy for tangible capital, degree of diversification, a dummy for multiple establishments, and a measure of demand fluctuations.

[2] Among the service industries, the effect of variability in demand for hospital services on costs has been studied (for example, Baker et al., 2004).

$$\ln Y = ß_0 + ß_1 \ln L + ß_2 \ln K + ß_3 \textit{ Diversification} + ß_4 \textit{ Dummy for Multiple Establishment} + ß_5 \textit{ Measures of Demand Fluctuation}$$

Value added (*va*) is calculated as sales minus costs plus wages and rents. As for the physical measures of output, the total number of yearly users (*users*) is available.

Labor (*L*) is the number of employees (*emp*) which includes part-time workers and temporary workers.[3] Unfortunately, the Survey does not collect information on capital stock, but the Survey does contain data on good proxies for fixed capital (*K*) in the personal-service industries. Specifically, floor area for movie theaters (*floor*), number of holes for golf courses (*holes*), number of courts for tennis courts (*courts*), number of lanes for bowling alleys (*lanes*), floor area for fitness clubs (*floor*), and number of boxes for golf driving ranges (*boxes*) were used. These proxies for capital stock capture the most important aspects of each service.

The share of the main business sales (*mshare*) is calculated as the sales of main services divided by the establishments' total sales. The coefficient measures the degree of the economies of scope. If there is an economy of scope, the coefficient of this variable will be negative. At the same time, this variable (*mshare)* may absorb a possible bias because the capital stock measures used here do not cover all of the fixed capital stocks. In this sense, this variable can be interpreted as a control variable. The dummy for multiple establishments (*multidum*) equals one if the establishment is part of a firm that has more than two establishments in the same industry, and the dummy equals zero otherwise. The coefficient of this variable indicates the existence of firm-level economies of scale.

Measures of demand fluctuations are (i) the share of users on weekends (*weekend*) and (ii) the coefficient of variation of the number of users per month (*month*). The sign of the coefficients of these variables is expected to be negative because demand fluctuation is detrimental to productivity. Table 1 shows the mean and standard deviation of these variables for each one of the six industries analyzed. With the exception of fitness clubs, the demand on weekends exceeds 50% of the total. As the standard deviations of demand fluctuations are not

[3] The number of hours is unavailable.

small, there is a considerable difference in demand variation among establishments.

3. Results

Estimation results using value-added as the dependent variable are presented in Table 2. As mentioned above, the coefficients of the measures of demand fluctuations are what is of interest here. The coefficients of *weekend* are negative and significant for movie theaters, golf courses, tennis courts, and golf driving ranges. The coefficients of *month* are negative and significant for five industries with the exception of movie theaters.

Table 3 contains the regression results using physical output (*users*) as the dependent variable. The coefficients of *weekend* are significantly negative for five industries with the exception of fitness clubs. The coefficients of *month* are negative and significant for five industries except movie theaters.[4] Almost all of the results obtained by using physical output measures confirm the results using value-added measures.

In order to understand the magnitude of the coefficients, Table 4 shows the effects of a one -standard-deviation demand fluctuation on productivity. Generally, when demand varied one standard deviation, the productivity of the establishment was 10% - 20% lower. These results indicated that smoothing demand had considerable effect on the productivity of service establishments. For example, the full utilization of paid leave may enhance the productivity of several service industries by dispersing the demand of weekends or certain months.[5] For this purpose, good labor management practices that achieve flexible timing of work without affecting production are essential.[6]

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[4] In addition to the abovementioned results, economies of scale in terms of establishment size and firm size, and economies of scope are found in almost all the examined service industries. These results are the same with Morikawa (2008).

[5] According to the General Survey on Working Conditions 2007 (Ministry of Health, Labour and Welfare), the average use of paid leave is 8.3 days in Japan. The utilization rate is 46.6%, which has been declining over the last fifteen years.

[6] Hamermesh et al. (2008) argue that synchronous behavior will be productive because of complementarities in generating output and consuming goods and services.

4. Conclusion

This paper, by using a unique data set, empirically investigates the relationship between demand fluctuation and the TFP of personal-service industries. Statistically and quantitatively significant negative effects of short-term demand variations on the establishment-level productivity are found in almost all service industries.

This result suggests dispersing holidays may have positive effects on the productivity of personal-service industries by smoothing demand. Although this paper analyzes only six industries, the result may be generalized to other service industries such as hotels and restaurants.

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Table 1
Mean and standard deviation

	Ratio of Weekends		Coefficient of Variation per Months	
	Mean	S.D.	Mean	S.D.
Movie Theater (2001)	57.53	15.49	0.501	0.266
Golf Courses (2001)	50.72	10.48	0.367	0.270
Tennis Courts (2001)	55.91	21.81	0.250	0.269
Bowling Alleys (2001)	50.72	10.99	0.212	0.114
Fitness Clubs (2002)	27.70	12.52	0.131	0.243
Golf Driving Ranges (2001)	51.92	15.43	0.220	0.233

Source: the Survey of Selected Service Industries (METI).

Table 2
Regression results using value added as dependent variable

	(1) Movie Theater		(2) Golf Courses		(3) Tennis Courts		(4) Bowling Alleys		(5) Fitness Clubs		(6) Golf Driving Ranges	
ln L	0.8368	***	0.7393	***	0.9526	***	0.6916	***	0.7373	***	0.6046	***
	(20.20)		(30.30)		(31.63)		(23.39)		(29.60)		(28.56)	
ln K	0.2491	***	0.5554	***	0.4151	***	0.4891	***	0.4377	***	0.8529	***
	(7.08)		(10.05)		(9.77)		(9.94)		(16.94)		(30.57)	
msale	-0.9227	***	-0.4137	***	-1.0745	***	-0.7149	***	-1.0830	***	-1.2869	***
	(-3.36)		(-3.15)		(-6.30)		(-6.56)		(-10.25)		(-14.05)	
multidum	0.4224	***	0.0897	***	0.1765	***	0.0760	**	0.4071	***	0.0269	
	(6.37)		(3.37)		(2.67)		(1.98)		(9.23)		(0.83)	
weekend	-0.0082	***	-0.0094	***	-0.0095	***	-0.0030	*	0.0019		-0.0033	***
	(-4.00)		(-7.16)		(-6.50)		(-1.70)		(1.22)		(-3.69)	
month	-0.0376		-0.9333	***	-0.5588	***	-1.3499	***	-0.7832	***	-0.8505	***
	(-0.32)		(-18.39)		(-4.97)		(-7.40)		(-9.75)		(-14.24)	
cons.	5.6094	***	6.4566	***	6.4013	***	6.3283	***	4.1333	***	4.9410	***
	(16.58)		(34.63)		(28.71)		(30.73)		(25.30)		(39.24)	
Number of obs	859		1,987		1,062		979		1,676		2,812	
Adj R-squared	0.6515		0.6213		0.6874		0.6646		0.7697		0.6918	

Notes: OLS Estimates with t-values in parentheses. *significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3
Regression results using physical output as dependent variable

	(1)		(2)		(3)		(4)		(5)		(6)	
	Movie Theater		Golf Courses		Tennis Courts		Bowling Alleys		Fitness Clubs		Golf Driving Ranges	
ln L	0.8131	***	0.2120	***	0.4925	***	0.4483	***	0.4981	***	0.3817	***
	(25.74)		(16.38)		(15.75)		(17.43)		(18.38)		(22.43)	
ln K	0.3094	***	0.7659	***	0.4408	***	0.7784	***	0.6652	***	1.0317	***
	(11.50)		(27.70)		(9.88)		(18.19)		(23.60)		(46.05)	
msale	0.8815	***	-0.0116		0.7956	***	0.5690	***	1.2000	***	0.4655	***
	(4.21)		(-0.18)		(3.55)		(6.06)		(10.38)		(6.34)	
multidum	0.5236	***	0.0178		0.3805	***	0.1407	***	0.4136	***	0.0755	***
	(10.42)		(1.40)		(5.98)		(4.22)		(8.58)		(2.89)	
weekend	-0.0079	***	-0.0089	***	-0.0100	***	-0.0051	***	0.0006		-0.0073	***
	(-5.17)		(-13.71)		(-6.03)		(-3.37)		(0.36)		(-10.14)	
month	0.3731	***	-0.8366	***	-0.8793	***	-1.0001	***	-0.8694	***	-0.8842	***
	(4.23)		(-33.58)		(-6.03)		(-6.43)		(-10.11)		(-18.37)	
cons.	6.3437	***	8.0166	***	7.3725	***	7.2134	***	3.1840	***	5.5413	***
	(24.56)		(84.29)		(27.09)		(40.37)		(17.88)		(54.80)	
Number of obs	894		1,798		702		993		1,708		2,868	
Adj R-squared	0.7770		0.7185		0.5093		0.6413		0.7179		0.7437	

Notes: OLS Estimates with t-values in parentheses. *significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4
Effects of demand fluctuation on productivity

	Weekly fluctuations		Yearly fluctuations	
	value added	physical	value added	physical
Movie Theater (2001)	-0.126	-0.123	-	0.099
Golf Courses (2001)	-0.098	-0.093	-0.252	-0.226
Tennis Courts (2001)	-0.206	-0.219	-0.150	-0.237
Bowling Alleys (2001)	-0.032	-0.100	-0.168	-0.205
Fitness Clubs (2002)	-	-	-0.190	-0.211
Golf Driving Ranges (2001)	-0.051	-0.113	-0.198	-0.206

Notes: Effects of 1 standard deviation. "-" means insignificant at 10% significance level.