The Efficiency of Small Manufacturing Firms in Japan

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ABSTRACT. It has been suggested that market structure will have an impact on within-industry differentials in efficiency, or cost disadvantages of small firms. To test this hypothesis, this paper examines the effects of market structure on the productivity (relative to industry productivity) of small manufacturing firms in Japan. The results show that market structure elements such as concentration and capital requirements work to the disadvantage of small-firm efficiency. The findings provide support for the hypothesis.

1. Introduction

A great deal of time and effort has been devoted to the study of the effects of market structure on industry profitability. The debates on the effects have suggested an interesting problem: the relationship between market structure and intra-industry differentials in efficiency. Some studies suggest that the efficiency differentials are likely to be associated with market structure. However, study is scantly that examines the relationship at an inter-industry model, using direct measures of efficiency.

This paper addresses the problem of the efficiency of small firms. This is the first attempt to examine the determinants of the relative productivity of small firms — the ratio of small-firm labor value-added productivity to industry productivity, in particular for Japanese industry in terms of cross-industry method. Although economists emphasize the "dual structure" between large and small firms, Japanese studies have not made an empirical industry-specific examination of this problem.[1] The organization of this paper is as follows: Section 2 provides a brief review of the theoretical and empirical studies regarding intra-industry differentials in efficiency. Section 3 describes the empirical methodology used here. Section 4 discusses the estimated results. And the final section concludes with suggestions for further research.

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2. Determinants of the efficiency of small firms

Some of the industrial organization literature suggest possible within-industry differentials in efficiency, or cost disadvantages of small to medium-sized firms. Among the relevant studies are the "efficient concentration" hypothesis by the "Chicagoans" such as Demsetz (1973), Brozen (1982) and Lustgarten (1984), the "intra-industry mobility barriers" hypothesis by Caves and Porter (1977), the "intra-industry strategic group" hypothesis by Caves and Pugel (1980), the "raising rivals' costs" hypothesis by Salop and Scheffman (1983), and the "dual economy" hypothesis by Averitt (1968) and Bowring (1986)[2].

We will review the possible factors conducive to the efficiency differentials, following the discussions in the above-mentioned studies. First of all, the primary factor is economies of scale in production, which are emphasized as a source of efficient industrial concentration, in particular by the Chicagoans. In an industry with larger scale economies, leading firms have an efficiency advantage over lesser firms in a given period. Also, the advantage may be related to the "learning effect", since large firms usually produce larger cumulative output. Small firms have a lower efficiency relative to large firms (hereafter relative efficiency).

Industries with such technical characteristics are likely to be concentrated. In this case, concentration is negatively associated with relative efficiency. In addition, high industrial concentration may allow less efficient small firms, since

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small firms are likely to be protected by market power, or higher prices set by leading oligopolists. Thus, it is expected that industrial concentration leads to lower efficiency of small firms relative to large firms.

The efficiency advantage of large firms implies that small firms may exist from their industries in the long run. But there continue to exist a great number of small firms, though their turnover is possibly heavy. Their persistence suggests that there are some within-industry barriers which impede their growth into the large-firm group. The growth barriers are "natural or external" in some cases, and are also "artificial or strategic" in others. These barriers are called the "intra-industry mobility barriers" (Caves and Porter, 1977).

The first growth barrier is product differentiation. It is because differentiation, either imagined or physical, forces small firms to make extra outlays of some sort in order to offset the "goodwill" assets of large firms. Also, differentiation does not allow for small firms to have a market share that is sufficient for efficient operation. The factor is artificial and strategic, as Salop and Scheffman suggest, since differentiation may lead to non-price rivalry such as advertising, proliferation of brand and product lines, and model changes. In this case, small firms bear large costs to follow the strategies of large firms. Thus, product differentiation is expected to lead to the efficiency disadvantage of small firms.

Second, technological innovation may limit the growth and efficiency of small firms. If large firms are more R&D-intensive and innovative, then efficiency is lower for small firms than for large firms. This relationship is emphasized by the Chicagoans. The hypothesis suggests that the efficiency differentials are larger for R&D-oriented industries than for less R&D-intensive industries.

However, the advantage of large firms over small firms in innovation is not supported empirically and theoretically. Also, the existence of a high technological opportunity may induce the growth of small firms. Then, the above-mentioned association may be distorted; relative efficiency may not be associated with innovation.

Third, large firms are more vertically integrated than small firms. The vertical integration may promote technical efficiency, since it reduces transaction costs associated with allocating resources via market mechanism. Therefore, in industries with larger vertical integration, the relative efficiency of small firms is lower.

In addition, the vertical integration in Japan includes the subcontract system such as Toyota Motor's "Just-in-time system", which is well known as the "Kanban" method. Parent firms, which are usually large firms, have a monopsonic power over subcontract firms, as well as reduced transaction costs. The consequence is lower costs of large firms. But small firms cannot utilize this system. Thus, industries with a greater subcontract system are likely to have larger inter-firm differentials in efficiency than those industries with less of a subcontract system.

The fourth barrier is large capital requirements. If capital requirements are large, then small firms with insufficient financing cannot grow to enter into the large firm groups, thus being limited in the growth and efficiency.

Finally, the disadvantages may result from the "raising rivals' costs" behavior by large firms, as noted earlier. Among the predatory behaviors are patenting, preemption of strategic resources by large firms, and excessive style changes. These tactics raise costs of small firms, since they are forced to make extra outlays to overcome these disadvantages, or to cope with the strategies of large firms.

Thus, the intra-industry efficiency differentials or the relative efficiency of small firms may be explained by market structure elements.[3] The arguments imply that an industry may have two different subgroups, large-firm and small-firm groups (Caves and Pugel, 1980). Such an industry is sometimes called the "dual economy or structure" (Averitt, 1968; Bowring, 1986). In other words, the dual economy hypothesis is based on the intra-industry differentials in efficiency, which result from the external and strategic barriers to intra-industry mobility.

An attempt has been scarcely made to empirically test the above relationships. Vatter (1955) only provides a helpful outline of some descriptive features. But, the existing empirical studies on small-firm presence and entry may be suggestive, since small-firm presence may be negatively related to relative efficiency, and the determinants of the former may be factors which have an influence on the latter. White (1981, 1982) shows

that capital intensity and consumer-goods industry are negatively associated with small-firm presence. Also, Acs and Audretsch (1989 and 1990) found that scale economies, concentration, capital intensity, advertising, capital requirements, R&D, and innovation, all have a negative effect on the presence of small firms.[4] From these findings, it is expected that scale economies, concentration, capital intensity, advertising or consumer goods, capital requirements, and technological progress are negatively related to relative efficiency of small firms.

Also, the effect of concentration may be to some extent supported by the findings, by Osborn (1970), Demsetz (1973) and Bowring (1986), that there exists no significant association between concentration and small-firm profitability, while industrial profitability is positively related to concentration, since the implication may be that as industrial concentration increases, the efficiency of small firms relative to large firms is likely to decline. But, Caves and Pugel (1980) show that small firms in more concentrated industries tend to exhibit profit rates similar to those of large firms. This finding may suggest that there is no significant differential in efficiency in concentrated industries. Therefore, the concentration-profitability relationship studies do not suggest a definite association between concentration and small-firm relative efficiency. The effect of concentration on relative efficiency is necessary to be examined directly.

3. Empirical methodology

The above section provided a set of hypotheses concerning the factors that trigger efficiency disadvantages of small firms in an industry. We will now describe the empirical methods that will allow tests of some of those hypotheses.

Ordinary least square regression was used at an inter-industry model. The relative efficiency of small firms, a dependent variable, was captured by the ratio of small firm productivity to industry productivity, which is called relative productivity (RP) hereafter. Productivity was measured by valued added per employee.[5] Therefore, relative productivity is; Vs/Ls/Vt/Lt, where V is value added. L the number of employees, and subscripts s and t stand for small firms and industry, respectively. If relative productivity is small, then efficiency disadvantages of small firms are large, and vice versa. The relative productivity used here is similar to the cost disadvantage ratio which is sometimes applied as an inverse measure of scale economies.

Small firms used here were all the firms which belong to the size class with 10 to 100 million yen in equity captial.[6] Japan's Small Business Administration defines small firms as firms with less than 100 million yen in equity capital. The present analysis followed this definition. But, firms with less than 10 million yen in equity capital were excluded, since such firms are apt to have an accounting bias; value added of those firms includes depreciation. Firm size may be captured by alternative measures. But, unfortunately equity capital is the only available published data in Japan. There remains the possibility that it will place a large firm with small equity capital in the small-firm category.

Relative productivity of 86 industries in 1984 was calulated from the equity capital size-class data of MITI, *1984 Census of Manufactures by Firm*. The relative productivity ranges from 1.24 to 0.26, and the sample average is 0.74. Among the industries with low relative productivity are for example detergents (0.26), record (0.31), liquors (0.34), radio and TV sets (0.34), IC (0.36), and vegetable oil (0.37). Also, the industries with high relative productivity include carpets (1.24), spinning of chemical fiber (1.16), raw silk (1.14), fiberbrick (1.06), pasteboard (1.05).

The previous discussion suggests some explanatory variables for the relative productivity test. Thus, the equation model used here is:

$$\begin{aligned} RP = {} & \beta 0 + \beta 1(MES) + \beta 2(CR) + \beta 3(ID) \\ & + \beta 4(MA) + \beta 5(VS) + \beta 6(SC) \\ & + \beta 7(KR) + \beta 8(IG) + \beta 9(RKL), \end{aligned}$$

where RP is relative productivity, MES minimum efficient size, CR concentration ratio, ID the character of industry, MA overhead intensity, VS value-added sales ratio, SC subcontract ratio, KR capital requirements (KR1, KR2), IG industry growth, RKL relative captial intensity, and $\beta i (i = 0, \ldots, 9)$ estimated parameters.

The equation was applied to Japan's 86 four-digit manufacturing industries in 1984.[7] The explanatory variables were all industry-level ones.

Next we will explain the explanatory variables included in the equation.

(1) *Minimum efficient size (MES).* Scale economies are captured by minimum efficient size, which is in turn proxied by the Comanor-Wilson (1967) approach; average size of the largest establishments accounting for more than half of industry value-of-shipments relative to industry value-of-shipments. MES is expected to exert a negative effect on relative productivity.

(2) *Concentration ration (CR).* Concentration is, as noted earlier, likely to trigger lower relative productivity of small firms, since it may reflect the efficiency effects such as economies of scale and learning effect, and in addition, higher prices in concentrated industries can protect small firms with less efficiency. Thus, concentration ratio may be negatively associated with relative productivity. To test the relationship, four-firm concentration ratio was included.

(3) *Character of industry (ID).* Product differentiation, either as a market structure element or as a market behavior, may, as the above discussion suggests, lead to more disadvantages for small firms. The degree of product differentiation, or its behavior is usually measured by advertising expenses and their ratio to sales. However, the data of advertising expenses are not available at a 4-digit industry classification level. Therefore, the degree is roughly captured by the dummy for the character of industry; 1 for consumer-goods industry, and 0 otherwise. Product differentiation is larger for consumer-goods industry than for non-consumer-goods industry. Thus, the dummy variable is expected to have a negative association with relative productivity.

(4) *Overhead intensity (MA).* This intensity is the number of non-production workers relative to industry employment. The ratio offers a rough and summary measure of the managerial and administrative capacity, that is, R&D, marketing and administrative capacities of an industry. The discussion of the previous section suggests that the intensity works to the disadvantage of small firms.

(5) *Value-added sales ratio (VS).* The degree of vertical integration or processing is roughly measured by the ratio of value added to value-of-shipments. The vertical integration may put small firms at a disadvantage, since they cannot integrate vertically, for example, due to increased capital requirements, and thereby cannot enjoy integration benefits such as reduced transaction costs. Thus, the ratio is likely to have a negative relationship to relative productivity.

(6) *Subcontract ratio (SC).* The extent of the subcontract system is captured by the ratio of "consigment production costs" to value-of-shipments. The costs mean payments that are made to subcontract firms. The subcontract system as a variation of vertical integration works to the disadvantages of small firms, as well. Thus, it is expected that the ratio has a negative influence on relative productivity.

(7) *Capital requirements (KR1, KR2).* Small firms cannot raise capital necessary for an efficient operation. This burden may limit their efficiency. Capital requirements are proxied by two alternative measures; the ratio of tangible fixed assets of an industry to the number of establishments in logarithm (KR1), and tangible fixed assets of an industry, multiplied by MES in logarithm (KR2). These variables very likely have a negative association with relative productivity respectively. KR2 was included in the equations with no MES and CR, because of its high correlation with them.

(8) *Industry growth (IG).* Higher demand growth is likely to allow the existence of small firms with less efficiency. That is, an industry with higher demand growth involves larger inter-firm differentials in efficiency. Therefore, industry growth may be negatively related to relative productivity. But, to the contrary, higher demand growth may provide for small firms the opportunity to improve their efficiency through expanding output. Therefore, the effect is indeterminate. The measure here is; 1984/1982 values-of-shipments minus one.

(9) *Relative capital intensity (RKL).* Relative productivity may be affected by the difference in capital-labor ratio. To take into account the influence, the ratio of small-firm's capital-labor ratio to industry's capital-labor ratio (hereafter, relative capital intensity) was included. The capital-labor ratio was measured by; tangible fixed assets/the number of employees. It is expected to be positively related to relative productivity.

All the explanatory variables but CR and ID are computed from the 1984 Census of Manufactures

by Industry. CR is from JFTC (1987) and Yano (1987). Their observation year was 1984 except for IG.

Summary statistics of the variables used are shown in Table I.

4. Estimated results

Table II shows the estimated equations. Many variables show the expected effects. Now we will examine the specific results in turn. First, both minimum efficient size, MES, and concentration ratio, CR, as expected, have a negative and significant influence on relative productivity of small firms. The two variables were alternatively included in estimation, since they are highly correlated. Also, their statistical significance was reduced due to their high correlation with RKL in equations 4 and 5. In industries with larger minimum efficient size, small firms have efficiency disadvantages against larger firms. Also, the negative effect of concentration implies that market power in concentrated industries allows inefficient small firms.

Second, the industry dummy, ID, also has a negative and significant relationship to relative productivity. The efficiency disadvantage of small firms is greater for consumer-goods industries than for producer-goods industries. This finding is not at variance with the expectation. Also, the fact is consistent with the prevalent finding that inter-firm differentials in profitability are greater for consumer-goods industries than for producer-goods industries.

Third, overhead intensity, MA, is negatively signed and statistically significant. Where an industry is characterized by intensive overhead capacity, or R&D, sales promotion and administrative capacities, large firms can enjoy specific advantages, but small firms bear disadvantages.

Fourth, both capital requirements, KR1 and KR2, are negatively and significantly related to relative productivity. These results suggest that the capital requirements work as an intra-industry mobility barrier to limit the growth and efficiency of small firms.

Fifth, industry growth, IG, is negatively signed and statistically significant. But, in equations 4 and 5, it is not statistically significant due to its high correlation with RKL. Higher demand growth is, as noted earlier, likely to allow inefficient small firms. This finding is interesting, since many analyses suggest that output growth is positively related to productivity growth at an industry level.[8] These two findings, taken together, suggest that demand growth doesn't provide for small firms the opportunity to improve efficiency relatively.

Sixth, the value-added sales ratio, VS, has the expected sign, and is statistically significant. Therefore, the higher the degree of vertical integration or processing, the lower the relative efficiency of small firms.

Seventh, the subcontract ratio, SC, takes a positive (therefore the "wrong") sign, and is not statistically significant. This result is a little puzzling. The absence of significance suggests that industries with a greater extent of subcontract are not those in which small firms are at an efficiency disadvantage. But, the variable may not capture precisely the extent of the subcontract system. Alternative measures are necessary to be devised.

Finally, relative capital intensity, RKL, has the expected sign and a strong relationship to relative productivity.

TABLE I
Summary statistics ($N = 86$)

Variable	Maximum	Minimum	Average	Standard deviation
RP	1.24	0.26	0.74	0.240
MES	22.98	0.20	5.12	5.125
CR	95.8	12.1	53.37	20.871
ID	1.0	0.0	0.29	0.461
MA	59.7	13.5	34.99	10.672
VS	64.59	11.80	36.18	11.348
SC	25.98	0.03	5.75	5.914
KR1	9.23	3.81	5.63	1.175
KR2	10.63	4.74	7.75	1.231
IG	111.13	−44.98	10.65	25.560
RKL	1.35	0.21	0.73	0.293

5. Concluding remarks

This paper has examined the determinants of the relative productivity of small firms. The results

TABLE II
Estimated results ($N = 86$)

No.	1	2	3	4	5
Constant	1.504	1.673	1.746	0.891	0.821
MES*10^{-2}	−1.059[b]				−0.695
	(2.007)				(1.560)
CR*10^{-2}		−0.255[b]		−0.163[b]	
		(2.388)		(1.727)	
ID	−0.133[a]	−0.113[b]	−0.107[b]	−0.102[b]	−0.117[a]
	(2.674)	(2.333)	(2.267)	(2.441)	(2.717)
MA*10^{-2}	−0.649[a]	−0.718[a]	−0.713[a]	−0.568[a]	−0.532[a]
	(2.924)	(3.371)	(3.462)	(3.108)	(2.861)
VS*10^{-2}	−0.367[c]	−0.426[b]	−0.355[b]	−0.354[b]	−0.326[b]
	(1.676)	(2.079)	(1.870)	(2.051)	(1.818)
SC*10^{-2}	0.536	0.318	0.529	0.170	0.289
	(1.246)	(0.822)	(1.245)	(0.517)	(0.810)
KR1*10^{-2}	−5.446[b]	−6.189[a]			
	(2.373)	(2.917)			
KR2*10^{-2}			−7.766[a]		
			(4.559)		
IG*10^{-2}	−0.228[b]	−0.167[b]	−0.190[b]	−0.088	−0.125
	(2.565)	(1.967)	(2.309)	(1.155)	(1.574)
RKL				0.414[a]	0.410[a]
				(5.893)	(5.697)
$\bar{R}^2$	0.349	0.362	0.383	0.511	0.507
[F]	[7.518]	[7.899]	[9.810]	[13.671]	[13.503]

Note: t-values are in paretheses; F is F-value.
Significance level; [a] 1%; [b] 5%; [c] 10% (two-tailed test).

have been remarkably consistent with expectations. The main findings are:

1. Among the factors conducive to the efficiency disadvantages of small firms are scale economies (minimum efficient size), concentration, the character of industry (consumer-goods industry), managerial and administrative capacity (overheaded intensity), and capital requirements.
2. Industry growth also leads to the coexistence of efficient large firms and inefficient small firms, that is, wider differentials in efficiency.
3. Vertical integration or processing has a negative impact on the efficiency of small firms. But, the subcontract system, a variation of the integration, has no effect.

These results suggest that market structure has an impact on the efficiency of small firms or the intra-industry efficiency differentials. In other words, the efficiency disadvantages of small firms are not a form of random noise. This conclusion is quite consistent with the arguments that there are different subgroups, in particular large-firm and small-firm subgroups in an industry.

This result suggests a further interesting problem; the survival of small firms in spite of their disadvantages. This problem is left to another paper, together with the refinements of the variables used here and the introduction of additional factors such as international competition and publicly-authorized cartels.

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Notes

[1] Caves and Uekusa (1967) and Sato (1989) provide an overview of Japanese small firms.

[2] Also, Worcester (1957), Scherer and Ross (1990), and Doi (1986) explain the inter-firm differentials in efficiency.

[3] The theoretical examination of the growth and efficiency of small firms is excellently made by Niino (1968), Baysinger *et al.* (1981) and McGee (1989).

[4] Schwalbach (1990) also shows similar relationships for German manufacturing industry based on the presence of small plants.

[5] In this paper, the definition of small firms is in terms of the absolute size of equity capital, not of market position in an industry. Also, unfortunately the available statistical sources do not show alternative measures for use in firm size classification.

[6] Many existing studies on the productivity measurements are excellently surveyed by Link (1987).

[7] Many industries were excluded from the sample for some reasons; (1) there was no small firms defined here; (2) the relevant data were not disclosed; and (3) the concentration ratio data were not available. As a consequence, 86 industries were available.

[8] This evidence is called "Verdorn Law".

References

Acs, Z. J. and D. B. Audretsch, 1989, 'Entrepreneurial Strategy and the Presence of Small Firms', *Small Business Economics* **1** (3), 193—213.

Acs, Z. J. and D. B. Audretsch, 1990, *Innovation and Small Firms*, Cambridge, Mass: the MIT Press.

Averitt, R. T., 1968, *The Dual Economy*, New York: W. W. Norton.

Baysinger, B. D., R. E. Meiners, and C. P. Zeithaml, 1981, *Barriers to Corporate Growth*, Lexington, Mass: Lexington Books.

Bowring, J., 1986, *Competition in a Dual Economy*, Princeton: Princeton University Press.

Brozen, Y., 1982, *Concentration, Mergers and Public Policy*, New York: Macmillan.

Caves, R. E. and M. E. Porter, 1977, 'From Entry Barriers to Mobility Barriers: Conjectural Decisions and Contrived Deterrence to New Competition', *Quarterly Journal of Economics* **91** (2), 241—261.

Caves, R. E. and T. A. Pugel, 1980, *Intraindustry Differences in Conduct and Performance: Viable Strategies in U.S. Manufacturing Industries*, Monograph Series in Finance and Economics, Monograph 1980—2, New York: Salomon Brothers Center for the Study of Financial Insitutions, New York University.

Caves, R. E. and M. Uekusa, 1976, *Industrial Organization in Japan*, Washington, D.C.: The Brookings Institution.

Comanor, W. S. and T. A. Wilson, 1967, 'Advertising, Market Structure, and Performance', *Review of Economics and Statistics* **49** (4), 423—440.

Demsetz, H., 1973, *The Market Concentration Doctrine*, Washington, D.C.: American Enterprise Institute.

Doi, N., 1986, *Oligopoly and Public Policy: Domestic and International Competition* (in Japanese), Tokyo: Yuhi-Kaku.

Japan, Fair Trade Commission (JFTC), 1987, *The Changes in Cumulative Production Concentration Ratios and Herfindahl Indexes in the Main Industries*, JFTC.

Link, A. N., 1987, *Technological Change and Productivity Growth*, Chur, Switzerland: Harwood Academic Publisher.

Lustgarten, S., 1984, *Productivity and Prices: The Consequences of Industrial Concentration*, Washington, D.C.: American Enterprise Institute.

McGee, J., 1989, 'Barriers to Growth: The Effects of Marekt Structure', in J. Barber, J. S. Metcalff, and M. Porteous (eds.), *Barriers to Growth in Small Firms*, London: Routledge, pp. 173—195.

Niino, K., 1968, *The Theory of Modern Market Structure* (in Japanese), Tokyo: Shin-Hyoron.

Osborn, R. G., 1970, 'Concentration and the Profitability of Small Manufacturing Corporations', *Quarterly Review of Economics and Business* **38** (2), 15—26.

Salop, S. C. and D. T. Scheffman, 1983, 'Raising Rivals' Costs', *American Economic Review* **73** (2), 265—271.

Sato, Y., 1989, 'Small Business in Japan: A Historical Perspective,' *Small Business Economics* **1** (2), 121—128.

Scherer, F. M. and D. Ross, 1990, *Industrial Market Structure and Economic Performance*, 3rd edition, Boston: Houghton Mifflin.

Schwalbach, J., 1990, 'Small Business in German Manufacturing,' in Z. J. Acs and D. B. Audretsch (eds.), *The Economics of Small Firms: A European Challenge*, Dordrecht: Klumer Academic Publishers, pp. 63—73.

Vatter, H. G., 1955, *Small Enterprise and Oligopoly: A Study of the Butter, Flour, Automobile, and Glass Container Industries*, Corvallis, Oregon: Oregon State College Press (Reprinted in 1979 by Arno Press).

White, L. J., 1981, *Measuring the Importance of Small Business in the American Economy*, Monograph Series in Finance and Economics, Monograph 1981—4, New York: Salomon Brothers Center for the Study of Financial Insitutions, New York University.

White, L. J., 1982, 'The Determinants of the Relative Importance of Small Business', *Review of Economics and Statistics* **64** (1), 42—49.

Worcester, D. A. Jr., 1957, 'Why Dominant Firms Decline', *Journal of Political Economy* **65** (4), 338—347.

Yano Institute of Economic Research, 1987, *Market Share in Japan.*