INDUSTRIAL STRUCTURE IN A DUAL ECONOMY*

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I. *Introduction*

In most nations, the structure of industrial firms is characterized by inequality. That is to say, a few firms produce the bulk of an industry's output, employ the majority of the labor force, etc.

This paper will investigate the inequality of firm size among Japanese firms. Such an investigation seems particularly appropriate in view of the rapid expansion of the Japanese economy, and the close relationship between a nation's industrial structure and changes in the size of firms. We shall further call attention to the so-called dual structure of the Japanese economy, mentioned together with capital concentration, by *Shinohara* (1962, p. 25) as one of the most important factors influencing Japan's high rate of growth.

Two stochastic models will be used in our investigation. These will be described in the following section. In Section 3, empirical results for the Japanese samples are compared with those obtained from studies of some other countries. Finally, in Section 4 the results are discussed with reference to particular characteristics of the Japanese economy.

II. *Two Stochastic Models*

One method of summarizing the size structure of industrial firms involves the use of distribution functions. The two such functions most frequently suggested in this context are the *lognormal* distribution, and the *Pareto* distribution. Both belong to a family of skew distributions and both can be derived using stochastic models that assume the law of proportionate effect to be valid.[1] These models imply that changes in industrial structure are considered as the result of a random process in which all companies, irrespective of size, have the same chance to attain a certain percentage rate of growth. Thus it is assumed that a billion-dollar company has the same probability for a percentage change in size as does the normally smaller, family-owned and operated firm.

The two models differ with respect to: (1) range of applicability, (2) assumptions concerning entry. As such, the lognormal model refers to firms of all sizes, whereas the Pareto model has been limited to firms of an extremely large size. This limitation for the Pareto model is introduced by *Simon* & *Bonini* (1958) in considering research results obtained by

* This research has been supported by a grant from the Bank of Sweden Tercentenary Fund. I am indebted to professor Naoto Sasaki for valuable comments.

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[1] This is also mentioned as "Gibrat's law" after its formulator (cf., *Gibrat*, 1931).

Bain (1956 and 1968, p. 175 ff.). Bain concluded that a firm's average cost curve is either U-shaped (with a long, flat base) or shaped as a " lying J ". Both of his interpretations imply that average costs are constant above a certain size. This led Simon & Bonini to assume the law of proportionate effect to be valid only for firms above a minimum, optimum size (i.e., the size at and above which average cost curves tend to level out).

The second difference between the two models has to do with their assumptions regarding entry. The lognormal model does not assume an inflow to the population, while the Pareto model does account for such a change. The Pareto model thus leads to a steady state distribution, whereas the lognormal does not.

Given the assumptions of the lognormal model——that the law of proportionate effect is valid and the total number of firms is constant——it can be shown that logarithms of firm sizes tend to be normally distributed (cf., *Aitchison & Brown*, 1957, p. 22 ff.). Thus the sizes of firms tend to be lognormally distributed.

The frequency distribution of the lognormal distribution can be described as:

$$f(\log S)=1/(\sigma\sqrt{2\pi})e^{-(\log S-\mu_T)^2/2\sigma^2_T} \qquad (1)$$

where $S=$size $(S>0)$

$\mu_T=$the mean of $\log(S)$ at time T

$\sigma_T=$the standard deviation of $\log(S)$ at time T

Measurements of concentration in the model are designated by the variable σ. A higher value of σ thus implies a higher degree of concentration.

Turning to the Pareto model, it has been shown by *Simon* (1955, p. 425 ff.) that, assuming the law of proportionate effect to be operative, firm sizes tend to be Pareto distributed for a population with a net surplus of firms entering. The frequency curve of this distribution is described as:

$$f(S)=MS^{-(\rho+1)} \qquad S>1 \qquad (2)$$

where $M=$a constant

$\rho=$a parameter

Concentration measurements are reflected in the parameter ρ, where $\rho=$(net growth of all companies) / (net growth of all companies entries and exits excluded). A small value for ρ implies a high degree of concentration and vice versa.

Both of the two models described have been discussed and challenged to some extent.[2] Previous studies, however, seem to indicate that there is no reason to doubt their usefulness, providing an analysis is limited to:

1. An entire industry exhibiting moderate change in its total number of firms when using the lognormal model.
2. Firms of an extremely large size when using the Pareto model.

Among the applications of the lognormal model to whole industries are those for the United Kingdom (*Hart & Prais*, 1956); France (*Morand*, 1967); and eight socialist countries (*Engwall*, 1972). As for the Pareto model, it has been effectively used in analyses of European corporate giants (*Engwall*, 1973); France (*Iribarne*, 1967); and West Germany (*Steindl*, 1965).[3] The results of these earlier studies will be kept in mind when applying these two

[2] Compare for example *Hymer & Pashigian* (1962), *Silberman* (1967), and *Wedervang* (1965).

[3] Noteworthy in this context is the remark by Steindl that the Pareto model is valid "only for a very small percentage of firms, but they are the firms which really account for the bulk of economic activity." (*Steindl*, 1965, p. 187).

stochastic models to Japanese firms in the following Section 3. Consequently, we will apply the lognormal model to industry-wide distributions and the Pareto model to those of large corporate enterprises.

III. *Empirical Applications*

To the author's knowledge the models in the previous section have not been applied to Japanese data. One reason for this circumstance is probably the fact that Japanese industry is considered to be of a dual structure. This type of industrial structure is defined by *Shinohara* (1970) as:

> "...the coexistence of modern large enterprises, which are equipped with high-level techniques, and smaller enterprises, including handicrafts, little business, small and medium size enterprises." (*Ibid.*, p. 324)

Shinohara states further that a dual economy is characterized by the tendency of firms to polarize into two groups: one containing very small and the other quite large firms. This state of affairs is not in accordance with the skew size distributions produced by the two stochastic models described above. We would therefore not expect the distributions of Japanese company sizes to follow those belonging to the skew family (i.e. the lognormal and the Pareto distributions).

In order to test the applicability of the stochastic models, size distributions can be plotted on lognormal and double logarithmic probability scales. If the models are applicable, the distributions will appear as straight lines. In a dual structure, however, it should be expected that the plots will form a convex curve from the origin.

We will now use the described technique in applications to two populations of Japanese firms and to distributions from some other countries. The lognormal model will initially be applied to distributions of establishments, followed by an analysis of the size distributions of the 100 largest companies. The classification by size in the first case is made according to the number of persons employed. In the second case, size is measured by sales. These units of measurement were chosen due to the availability of data. The choice of measurement unit, does not seem to significantly influence the results in either case, since various methods for measuring size have been found to be highly correlated (cf., *Bates*, 1965, p. 133 ff.; *Engwall*, 1973, Chapter 2; and *Rosenbluth*, 1955, p. 92).

Concerning the distribution of establishments, we have investigated the distribution in Japan in comparison with those in (1) USA, (2) Sweden and (3) Poland, i.e. the Japanese data have been compared with data from a capitalistic country, a country with a " mixed economy ", and a socialist country.[4]

The result of the plotting in lognormal probability scale is shown in Figure 1. The

[4] The data refer to establishments having more than 10 employees in 1967.
Sources: Japan —Statistics on Japanese Industries, 1970, pp. 26-27.
USA —Statistical Abstract of the United States, 1969, p. 475.
Sweden —Statistisk Årsbok, 1969, pp. 126-127.
Poland —The Polish Embassy in Stockholm.
The data are reproduced in Appendix 1.

FIG. 1. DISTRIBUTIONS OF ESTABLISHMENTS IN THE US, JAPAN, SWEDEN AND POLAND, PLOTTED IN LOGNORMAL SCALE[5]

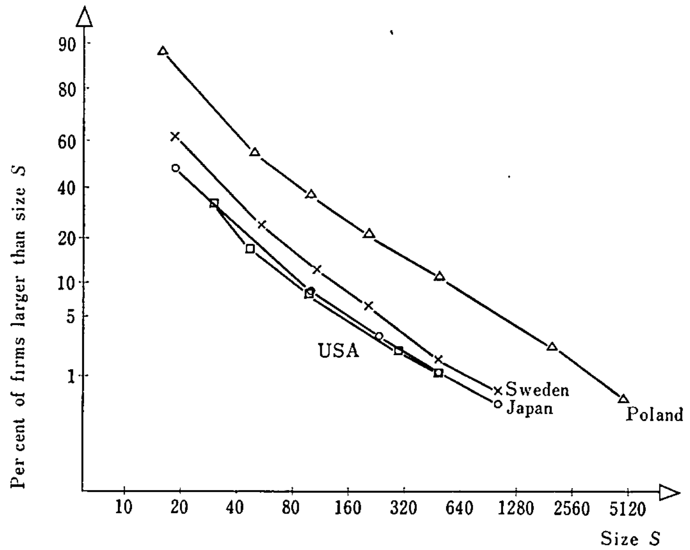


figure does not indicate any significant difference between the distributions as far as log-normality is concerned. All four lines are relatively straight.

Figure 1 can also be used in comparing the degree of concentration within the countries considered, since the slope of the lines reflects the size of the variable σ. One way of estimating the size of σ is to measure the size of one standard deviation. This is usually done using

$$\sigma^* = ln\{1/2(S_{50}/S_{16} + S_{84}/S_{50})\} \quad (4)$$

where S_i=size at i^{th} percentile

(cf. *Aitchison & Brown*, 1957, p. 32)

or

$$\sigma^* = ln\, S_{84} - ln\, S_{50} = ln(S_{84}/S_{50}) \quad (5)$$

(cf. *Pessemier*, 1966, p. 173)

In our application, however, S_{50} cannot be read off the diagrams. Consequently, we choose to estimate σ as

$$\sigma^* = ln\, S_{98} - ln\, S_{84} = ln(S_{98}/S_{84}) \quad (6)$$

Using (6), we obtain the results shown in Table 1.

TABLE 1. THE ESTIMATED VALUES OF σ

	Japan	USA	Sweden	Poland
σ	1.655	1.709	1.573	1.833

Table 1 lends some support to the observation as to similarities in the degree of concentration. A measure of concentration ranging between zero and unity might give still better

[5] Size measured in number of employees.

comparability, however. The Gini-coefficient, which adopts low values for a low degree of concentration and vice versa is such a measure.[6] The value of the Gini-coefficient can be derived if σ is known for a distribution assumed to be lognormal (Cf. *Aitchison & Brown*, 1957, pp. 13 and 112). Applying this technique, we obtain the values shown in Table 2.

TABLE 2. VALUES OF THE GINI-COEFFICIENT

	Japan	USA	Sweden	Poland
Gini-coefficient	0.759	0.773	0.732	0.803

It should be mentioned that our results are somewhat uncertain. First, it is difficult to estimate the differences between the units of observation. Second, the technique used to estimate σ has its deficiencies. Nevertheless, the similarity in concentration indicated by the diagrams is astonishing.[7] Indeed, the results rouse some thoughts as to the duality of the Japanese economy. This will be treated in the following section, but first we will analyze the size distribution of the 100 largest companies in Japan, the United States and Scandinavia.[8] These distributions are displayed in Figure 2.

First of all, Figure 2 shows the difference in company sizes among the three samples, the United States having the largest giants, Sweden the smallest, with those of Japan in between. Second, the figure indicates similarities in the slopes of the lines, i.e. similarities in the degree of concentration among the 100 largest firms in the three samples.

Computation of the slopes of the lines (ρ) seems to support this observation. The values obtained are shown in Table 3, which also displays the net contribution from new giants / the total net growth of all giants (α), and values of the Gini coefficient (G).[9]

The results imply that concentration among the 100 largest firms is greatest in the

TABLE 3. VALUES OF ρ, α. AND G

Variable	ρ	α	G
Japan	1.72	0.42	0.408
USA	1.47	0.32	0.515
Scandinavia	1.59	0.37	0.459

[6] For a discussion of this measure cf. e.g. *Yntema* (1933).

[7] The closeness of the lines for the United States and Japan also indicates that the average size of establishments——measured by the logarithm of the geometric mean——is about the same in the two countries. Poland exhibits the largest average size.

[8] Unfortunately, the data for the 100 largest companies in Poland was not available and could not be included in the analysis. Scandinavia was substituted for Sweden for the same reason.

The sources are:

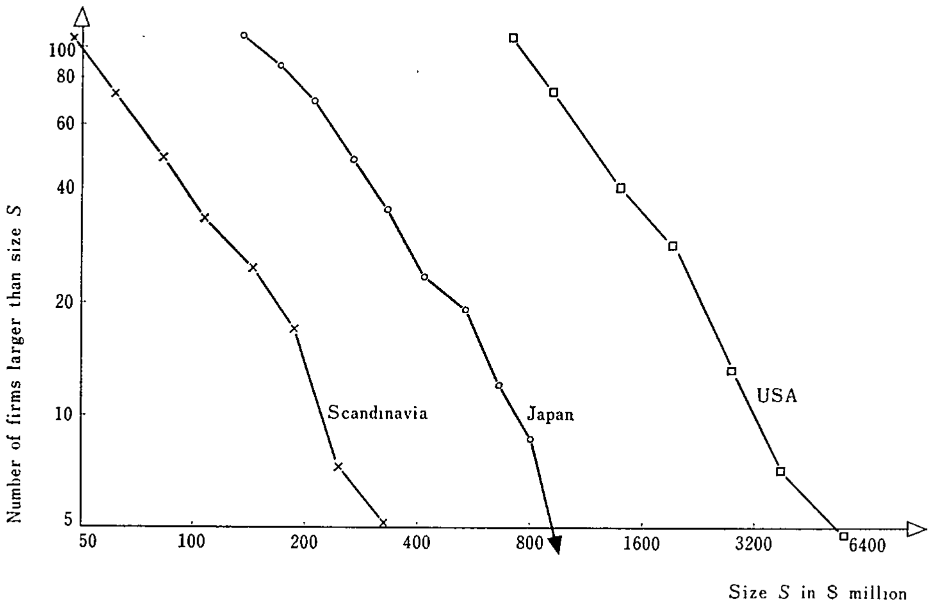
Japan —Economic Research Department of Mitsubishi Bank, Tokyo
USA —*Economic Concentration, Part* 5 (1967), p. 2168-70
Scandinavia —*Ekonomen* (1966: 20), p. 18-28

The data for the United States and Scandinavia refer to December 1965, and the data for Japan to March 1967. The difference of somewhat more than one year in the point of observation would not appear to influence the results very much, since the distributions of large firms change only slowly (cf. *Engwall*, 1973, Chapter 4).

The data are reproduced in Appendix 1.

[9] The values of the Gini coefficient are estimated by a formula suggested by *Quandt* (1966, p. 62).

FIG. 2. THE 100 LARGEST FIRMS IN THE UNITED STATES, JAPAN AND SCANDINAVIA PLOTTED IN DOUBLE LOGARITHMIC SCALE[10]



United States, next greatest in Scandinavia and least in Japan.

The values of the parameter α indicate that companies entering the group of giants contribute relatively more to the total growth of the group in Japan than in the other two samples. The closeness of the values for both parameters ought to be stressed.

IV. *Discussion of the Results*

In the previous section we found nothing to suggest that the stochastic models producing skew size distributions of firms are less applicable to Japan than to the other countries investigated. This result makes it most relevant to investigate the validity of the assumptions of the two models for Japan, which state that

1. Firms in all size ranges have the same opportunities for growth (i.e. the law of proportionate effect is valid).
2. The *total* distribution consists of a constant number of firms over time.
3. The *giant* size distribution is characterized by a net inflow into its lower classes.

As far as the law of proportionate effect is concerned the argument concerning constant average costs for the giants is probably also valid for Japan. Concerning the total size distribution, one probable explanation is that we can find disadvantages as well as advantages of scale. This seems to be true for Japanese as well as for non-Japanese firms. There is

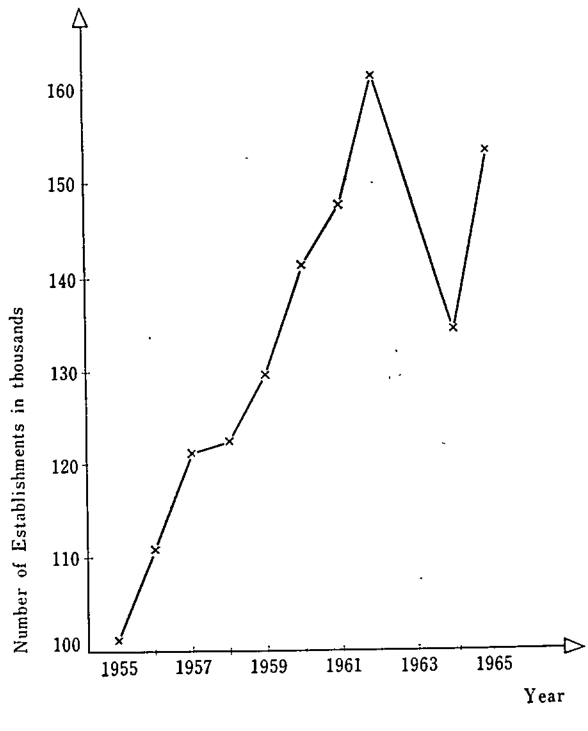
[10] Size measured by sales.

considerable evidence that large firms enjoy technical advantages as a result of scale.[11] However, we also know that large firms experience disadvantages with respect to the wage rate per employee. For example, *Shinohara* (1970, p. 305) reports a continuous increase in wages per man as size increases.

Thus, one reason for the law of proportionate effect to be valid for Japanese industries might be that differences in wage structure tend to outweigh the technical advantages of scale. This would imply that average cost curves are constant over the whole size range. This quite obviously conflicts with Bain's findings on cost curves, and further investigations of this hypothesis ought to be performed.

A second explanation of small and large firms having similar growth opportunities is their economic interrelations, i.e. small and medium-sized firms are often suppliers of parts or sub-contractors to large firms.[12] Thus, production functions being linear and homogeneous, we would expect small and medium-sized firms to grow at rates similar to those of large firms.

FIG. 3. THE NUMBER OF ESTABLISHMENTS WITH 10 OR MORE EMPLOYEES IN JAPAN 1955—1965



Source: Statistics on Japanese Industries 1968.

[11] We might also mention the advantage of larger firms in attracting better educated personnel (Cf. *Maruo*, 1965, p. 627 f.).

[12] Concerning Japan, cf. *Japan Economic Yearbook* (1970, p. 106): "Nearly 55 per cent of the total number of medium and small enterprises in Japan have subcontract relations with big business."

A third explanation for the validity of the law of proportionate effect also among small firms could be a counteracting effect from entry. As is illustrated in Figure 3, the number of Japanese firms has been on the increase during most of the period 1955-1965.[13]

One reason why entering firms (i.e. firms attaining a size larger than 10 employees) should face lower average costs than already existing small firms could be the many individual proprietors and family workers in the lower size classes.[14] Such employees probably do not demand as high wages as nonfamily employees. Thus, a combination of Bain's cost curves and an inflow of family enterprises in the lower size classes might very well produce circumstances causing the law of proportionate effect to be valid over the whole size range.

As for the entry of giants, the third assumption implies a continuous flow of firms past the smallest giant size considered.[15] Further, the upward movement in this size area is stronger than downward movement. Such circumstances seem hardly unlikely in an expanding economy like Japan's, which has a high positive growth rate. Actually, this implies that the net effect of expansion and contraction of firms has been positive, i.e. that upward movements have been stronger than downward ones.

Summing up, we have mentioned some reasons why the two models should be valid for Japan. In addition, the results indicate that the size distributions of Japanese firms seem to be not very different from those of other countries. This is somewhat astonishing in view of the notion of the duality of the Japanese economy, and seems to support Ohkawa's argument that such terms as "differential employment structure" or "multi-layer structure" would be more relevant than "dual economy" as descriptors of the Japanese economy.[16]

The results might also be interpreted as a support for Bieda's argument that dual structure

"is not a phenomenon limited solely to Japan. Almost all countries which used to be traditional and have lately experienced rapid economic growth develop some features of duality.... (*Bieda*, 1970, p. 186).

Both interpretations suggest that, all things considered, the Japanese industrial structure seems to have very much in common with that of other countries. This in turn may produce the conclusion that "duality" has to some extent to do with classification. It may emerge from considering a dichotomy between small and large firms instead of an analysis of the complete distribution. Although the dichotomial approach may provide interesting information, analyses of complete size distributions should be made as well.

V. *Conclusions*

We have found the size distribution of establishments as well as that of the 100 largest companies in Japan to belong to a family of skew distributions. The two distributions

[13] The exceptions are 1963 and 1964, probably a result of a tight money policy during the first part of the 1960's (cf. e.g. *Broadridge*, 1966, p. 92).

[14] As has been pointed out by *Shinohara* (1970, p. 305), as much as 26.5% of the total employed labor force consists of individual proprietors and family workers.

[15] In the present study this size limit is ¥48,500 million for the Japanese giants.

[16] Cf. *Ohkawa* (1959).

can be approximated by the lognormal and the Pareto distributions, respectively. These findings are in accordance with conclusions reached with respect to several other countries. We have also found concentration in Japan——measured by the parameters of the lognormal and Pareto distribution——to be similar to that in the other countries considered. Moreover, the average size of establishments was found to be approximately the same.

APPENDIX 1. THE DATA USED

In order to give an impression of the data used in this paper, the seven distributions used are reproduced here in tabular form.

TABLE A1. DISTRIBUTIONS OF ESTABLISHMENTS WITH MORE THAN 10 EMPLOYEES[17]

Size Class	per cent of establishments			
	Japan	USA	Sweden	Poland
11— 50	91.5 (11—100)	81.0	73.6	46.7
51—100		10.1	13.1	17.6
101—500	7.3	7.6	11.6	24.1
>500	1.2	1.3	1.7	11.6
Total	100.0	100.0	100.0	100.0

TABLE A2. DISTRIBUTIONS OF THE 100 LARGEST COMPANIES[18]

Size Class	per cent of companies		
US $ million	Japan	USA	Scandinavia
< 100	—	—	57
100— 199	32	—	30
200— 399	43	—	9
400— 799	17	16	4
800— 1599	8	53	—
1600— 3199	—	20	—
3200— 6399	—	8	—
6400—12799	—	2	—
≥12800	—	1	—
Total	100	100	100
Smallest size US $ million	134.7	701.7	47.4

[17] For sources see p. 78.
The limits for the United States and Japan are 11-49, 50-99, 100-499 and ≥500.
[18] For sources see p. 80.

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