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# INNOVATION AND MARKET STRUCTURE IN PREWAR JAPAN

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## *Abstract*

In this paper, I examine whether Schumpeter's Hypothesis on innovation and market structure with regard to Prewar Japan is valid or not through statistical analysis. Then, with respect to the effect of the Zaibatsu (family-controlled business group) on Japanese technological development in the prewar era, attempt to show my own findings.

*Key Words:* Schumpeter's Hypothesis, Zaibatsu.
*JEL classification:* N65, O31.

## I. *Introduction*

J. A. Schumpeter pointed out the significance of innovation in contemporary capitalism, and stressed the role of the entrepreneur as a key vehicle of innovation. He also urged that innovation might be fostered not by smaller enterprises but by large enterprises, not in a competitive market but in a monopolistic market. This is the "Schumpeter's Hypothesis". Although a number of positive studies were made, mainly in Western countries, there has not quite been a unified view regarding the Hypothesis hitherto.[1] In Japan, similar studies were developed by Imai [1970], Doi [1977, 1993], Uekusa [1982], Murakami [1986, 1988] and Wakasugi, et al [1996]. However, these studies were focused on postwar Japan, not on prewar Japan. The reason for this might be the scarcity of relevant information sources.

If no investigation is made of prewar Japan, the broader study of the relationship between innovation and market structure remains vague. This is what triggered me to attempt to deal with the prewar issue. In this paper, I will challenge the issue by using my own resource acquisition and methods of analysis. In my understanding, there existed a monopolistic market formed by large enterprises in modern industries, also a competitive market in which innumerable smaller enterprises coexisted in traditional industry in those days. Therefore, as large enterprises played a leading role in innovation in modern industry, so did smaller

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[1] For comprehensive survey with regard to this issue, see Kamien and Schwartz [1982], Baldwin and Scott [1987], Cohen and Levin [1989].

enterprises in traditional industry.

In Section 2, the relationship between scale of enterprise and innovation will be discussed. Firstly, in "*Survey of Industry*", I will compare the features of traditional industry and modern industry. After that, using 'Company History' a statistical examination on the relationship between the scale of enterprises and innovation will be made. In Section 3, the role of Zaibatsu in affecting innovation will be examined.

## II. *Scale and Innovation*

### 1. Data

In order to clarify, quantitatively, the relationship between the scale of enterprise and innovation, obtaining accurate statistical data is essential. Actually, however, the data not only of each scale of enterprise but of each enterprise are quite limited. "*Factory Statistics*" is the most comprehensive survey showing the production structure and level of technology in the manufacturing industry. It contains the statistics of each factory in terms of scale, number of employees, and horsepower of motors in detail, but fails to include several important indicators, such as value of production and fixed capital.[2] Therefore, an accurate measurement of technology gap in each scale of enterprise might be difficult by means of the statistics.

On the other hand, there is another data source— "*Survey of Industry*" which was published at several major cities (Tokyo, Osaka, Nagoya, Yokohama and Kobe) from 1933 to 1935. Data on each city was classified into 10 groupings (12 groupings for Yokohama) in terms of the value of capital. From this data, I successfully obtained various management information such as the number of factories, issued capital, horsepower of motors, value of production, the number of employees, cost of raw materials and fuel, wages, taxes and interest. Although this information does not always directly reflect the exact state of innovation in those days, it indirectly shows the level of technology and manufacturing efficiency in each industry. Nonetheless, there are several problems on this data. Firstly, with reference to the data from 1932 to 1933, it is impossible to make comparisons with other periods. Secondly, the published data of each city was not collected under uniformed conditions. For example, Osaka's Survey had no mention of value of capital. In the final analysis, I decided to use Tokyo and Nagoya's Survey as core data, and Yokohama's and Osaka's are supplemental data.

### 2. Statistical analysis

Here, the relationship between scale of enterprise and innovation is examined by using 2 resources. One is an examination of production coefficient of each scale of capitals using "*Survey of Industry*". The other is consideration on relationship between number of employees and number of patents and utility models using 'Company History'.

To analyze the former, first of all, pharmaceuticals manufacturing from modern industry, and wood manufacture from traditional industry are selected. Figure 1 (a, b) shows the production coefficient for each type of manufacturing. Both coefficients are very close about a

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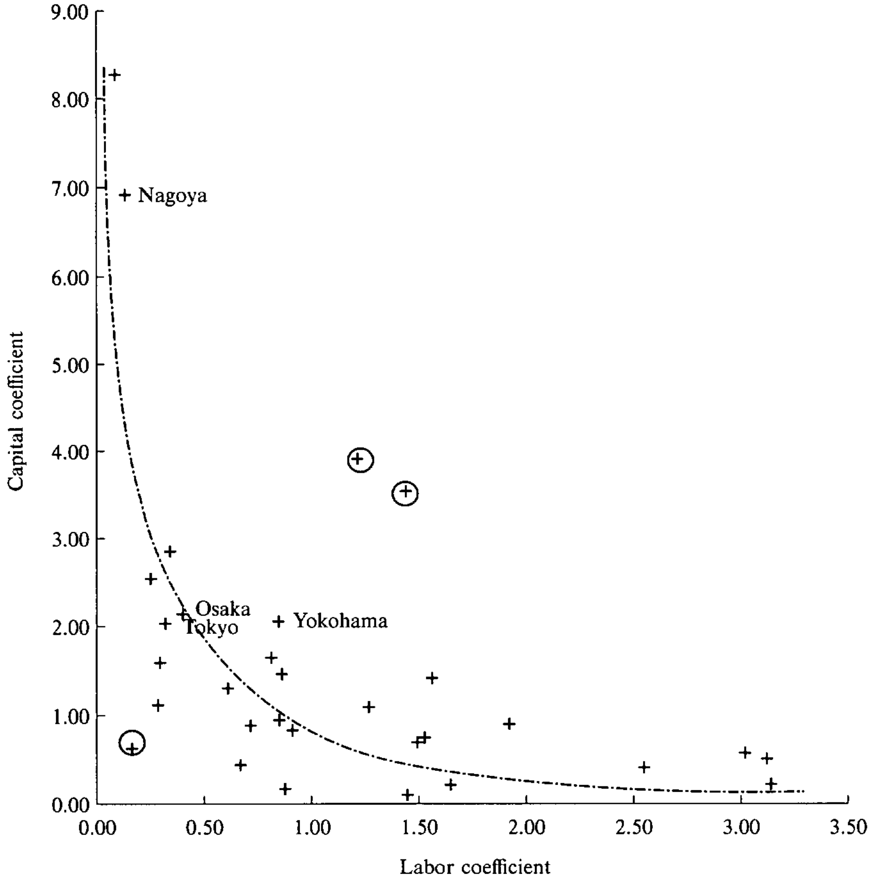
[2] Fractional data about the value of production (e.g. 1929) is recorded.

FIGURE 1 (a). PRODUCTION COEFFICIENT BY RANGE OF CAPITAL VALUE IN PHARMACEUTICAL MANUFACTURE




*Note:* 1) 31 samples. Less than 100 yen in Tokyo sample, range of 5000−10000 yen in Nagoya sample range of 10000−50000 yen in Yokohama sample were excluded.

2) Regression equation: $\log K = -0.086 \quad -0.805 \log L$, adj.$R^2=0.544$

$$(-1.488)(-5.766)$$

F value is 33.248, ( ): t-value.

The values marking ○ in the chart above were excluded to calculate.

3) Isoquant was made by freehand writing.

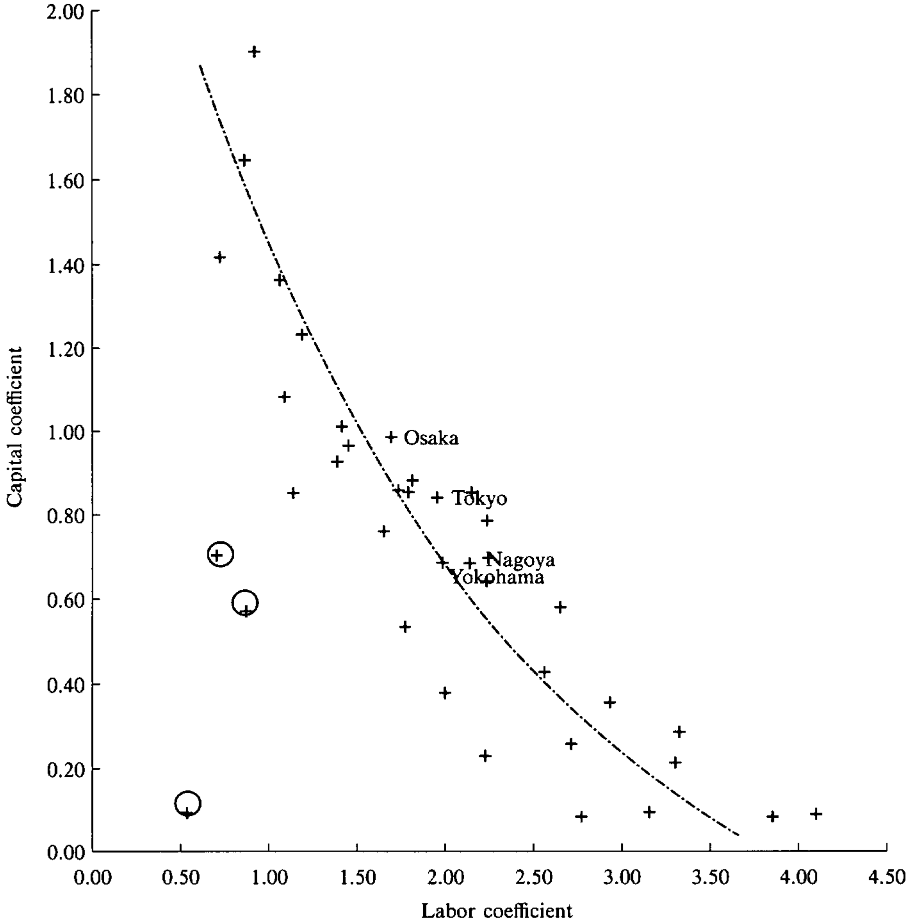
4) Labor coefficient (L) = the number of employee / gross VA (1000 Yen).

Capital coefficient (K) = fixed capital / gross VA (Yen).

Gross VA = (value of production + value of consignment production and repairing cost) − (cost of raw materials, fuel and power).

*Source:* See the text.

FIGURE 1 (b). PRODUCTION COEFFICIENT BY RANGE OF CAPITAL VALUE IN WOOD MANUFACTURE




*Note:* 1) 40 samples. More than 500,000 yen in Tokyo and Osaka samples, range of 100,000−500,000 yen in Yokohama sample were excluded.

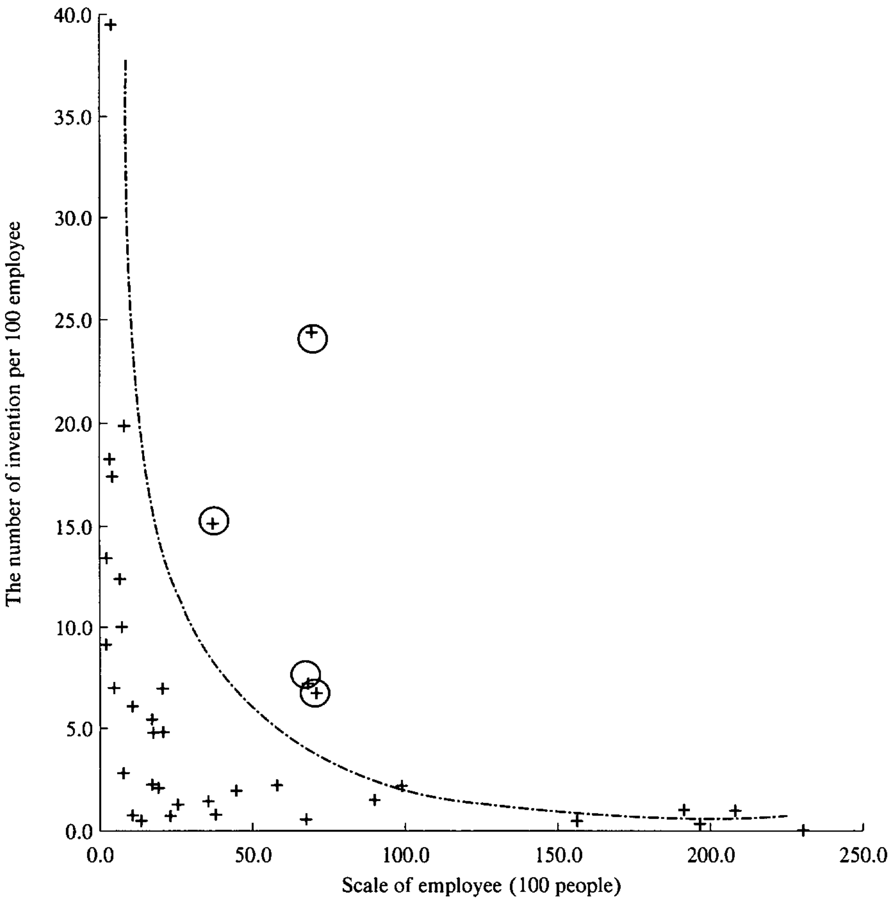
2) Regression equation: log K=0.190 −1.595logL, adj.$R^2$=0.712
(3.480)(−9.495)
F value is 90.155, ( ): t-value.
The values marking ○ in the chart above were excluded to calculate.

3) Isoquant was made by freehand writing.

4) same as Figure 1(a).

*Source:* See the text.

FIGURE 2. RELATIONSHIP BETWEEN SCALE OF ENTERPRISES AND INNOVATION




*Note:* 1) 38 sample enterprises are following:
Kawasaki Shipbuilding Ltd., Shimazu Corporation, Japan Optical Industry Association,
Sinagawa Refectories Co., Ltd., Japan Ceramic, Denki Kagaku Kogyo K.K.,
Asahi Vehicle Industry Ltd., Asahi Chemical Industry Ltd., Nihon Noyaku Co., Ltd.,
Yokohama Rubber Co., Ltd., Meiji Gomu Kasei Ltd., Noda Soy Sauce, Ltd, Ajinomoto Co., Inc.,
Toray Industries Inc., Toho Rayon Co., Ltd., Gunze Limited, Niigata Engineering Co., Ltd.,
Yasukawa Electric Corporation, Dai'ichi Kogyo Seiyaku Co , Ltd., Nippon Paint Co., Ltd.,
Toa Paint Co., Ltd., Dai'Nippon Toryo Co., Ltd., Honen Sesame Mills Inc., Sankyo Co., Ltd.,
Dai'Nippon Artificial Co., Ltd., Asahi Denka Kogyo K.K., Nippon Sanso Corporation,
Nippon Carbon Co., Ltd., Nippon Carbide Co.,Ltd., Fuji Photo Film Co., Ltd., Aichi Electric Co.,Ltd.,
Meidensha Corporation, Ibiden Co., Ltd.,Yasutate Electric Corporation, Ishii Iron Works Co., Ltd.,
Nippon Hume Pipe Co., Ltd, Ishikawajima-Harima Heavy Industries Co.,Ltd.,
Harima Shipbuilding Co., Ltd.

2) Data of Sibaura Engineering Works., Co Ltd., Hitachi, Ltd. and Japan Mining Industries, Co., Ltd. were excluded.
3) Almost all data are from 1936 to 1945, but some are in around 1951.
4) The number of invention is the sum of patents and utility models each enterprise possesses (partly included, the number of application).
5) Regression equation: $\log Y = 1.479 \quad -0.805 \log X$, adj.$R^2 = 0.593$
$(9.076)(-7.107)$
F value is 50.505, ( ): t-value.
6) The value marking ○ in the chart above was excluded to calculate.
7) The curve was made by freehand writing.

*Source:* See the text.

single 'isoquant', which explains that capital and labor are in substitutive relation by the gross. In other words, smaller enterprise's capital coefficient was lower so that it experienced lower productivity. On the contrary, large enterprise's productivity was higher because of its substituting its considerable capital equipment for labor power. This means that both smaller enterprise and large enterprise belong to an identical system of production technology. According to the figures, therefore, even though a few examples of fluctuation of capital coefficient and labor coefficient are recognized, the fluctuation was regarded as only the change of capital-labor ratio under the identical system of production technology; it means there was no transition to different technology system.[3]

Subsequently, the relationship between scale of enterprise and innovation is analyzed by using company history. Through researching enterprises' company history with records of both number of employees and number of inventions (patents and utility models), 41 companies' information was obtained.[4] Figure 2 shows correlation between the number of employees (variable of enterprise scale) and the number of inventions per 100 employees (variable of innovation). According to those figures, the data does not make any stand on "Schumpeter's Hypothesis" which says large enterprise realizes plenty of innovation beyond the degree expected by its scale. Although, in fact, large enterprise reaps more of the much fruits of innovation than smaller enterprise, it is not obvious that large enterprises have definite scale advantage. Based on my analysis, it is emphasized that smaller enterprises, rather, innovate more actively than large enterprises do.

Before concluding the preceding analysis I have made, however, a comment on the data should be pointed out. Generally, the larger the enterprise, the more it can afford to record a long and detailed company history. As to the framework of analysis, I selected enterprises with more than 200 employees. The average number of employees of 38 companies was 4,556 employees.[5] In short, it is necessary to note that the preceding analysis deals with enterprises above a certain scale, and does not contain smaller enterprises.

## III. *Zaibatsu and Innovation*

It is well known that the position of the Zaibatsu in the prewar Japanese economy was outstandingly important. So, innumerable studies of it have been made. The stream of the studies is mostly divided into 2 groups; one stream is a Marxian economist group, and the other is business historian group. The Marxian group tended to place the studies of Zaibatsu' history as part of a structural analysis of Japanese capitalism, whereas the historian group tended to clarify the business behavior and business factors of Zaibatsu by means of business administration approach. Both of them have produced plenty of research outcomes.[6]

As well as these studies of Zaibatsu history, there is another stream. Ohkawa and Rosovsky stress the role of Zaibatsu. They said that, "The Zaibatsu were leaders in the development of technologically more sophisticated industries. They were major importers of

[3] For an analysis on textile industry by similar methodology, see Odaka[1989].

[4] A series of company histories from the Innovation Center, Hitotsubashi University were used.

[5] Nippon Mining Co., Ltd. and Hitachi, Ltd. employed so many employees, approximately 50 thousand each, that these enterprises were excluded from this analysis.

[6] See, for details, Japan Society of Business History [1985], pp.106-110.

Western technology and innovators. ......Given that the issue of that day, as now, was growth rather than economic democracy, there developed in Japan a certain kind of bigness that was unacceptable elsewhere but quite suitable in this setting"[7]. This view contains a somewhat unique standpoint that traditional historian studies have not touched on. However, this thinking has not been in the spotlight of academic world yet because its advocates did not prove the arguments for their theory. In this section, I would like to consider the role of Zaibatsu in the light of technology development.

### 1. Zaibatsu and technology importation

Technology importation in modern industry is different from that in traditional industry. Firstly, modern industry tends to import plenty of advanced Western technology, because, fundamentally, the industry itself is formed on imported technology. On the contrary, traditional industry does not tend to import western technology, because it is supported by traditional skills. In the light of method of importation, secondly, modern industry adopts the method of high dependence on technology-providing countries (e.g.; direct foreign investment). On the contrary, traditional industry adopts the method of importation with low dependence of technology-accepting countries (e.g.; imitation production). Thirdly, modern industry has a hierarchal monopolistic market in which a few large enterprises stand at top position. Hence, the importation is usually conducted by large enterprises. On the other hand, traditional industry has a competitive market which innumerable smaller enterprises form. Hence, smaller enterprises themselves can be major players in technology importation.

Technology importation in shipbuilding as a modern industry was conducted mainly by large enterprises connected with Zaibatsu. For example, from 1904 to 1921, 40 major importation cases were conducted by just 5 companies. The details are following: Mitsubishi Shipbuilding Co., Ltd. 21 cases, Kawasaki Shipyards Ltd. 11 cases, Osaka Iron Factory, Ltd. 3 cases, Ishikawajima Shipbuilding Co., Ltd. 4 cases and Harima Shipbuilding, Ltd. 1 case.[8] Technology importation in the aircraft industry was similar to that in shipbuilding. In addition, 50 of the 56 importation cases were conducted by companies which had strong connection with Zaibatsu. The details are following: Mitsubishi Heavy Industry Ltd. 21 cases, Kawasaki Aircraft Ltd. 10 cases, Nakajima Airplane Ltd. for cases, Aichi Aircraft Ltd. 3 cases, Ishikawajima Aircraft Ltd. 1 case, Tokyo Gas & Electric Industries Co., Ltd. 1 case, Sumitomo Heavy industry Ltd. 2 cases, Nippon Gakki 1 case and Japan International Air Line Ltd. 1 case.[9]

In contrast, Independent development of farming equipment used in agricultural production was regarded as important rather than technology importation in early stage. For example, 99 patents cases were approved in 1885. Concerning farming equipments, there were 18 patent cases.[10] Also, among them, we can find well-known inventions, such as a tea manufacturing machine (2nd -4th version) produced by Kenzo Takabayashi, a mat looming machine (23rd -24th version) produced by Minki Isozaki. In short, in the case of farming tools, neither technology importation nor innovation is related to Zaibatsu influence.

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[7] See Ohkawa and Rosovsky [1973], pp. 219-220.
[8] Ministry of International Trade and Industry, edited (MITI) [1979], p.141.
[9] The remaining 6 cases were for Army and Navy orders. For details, see MITI *ibid*, p. 457.
[10] For details, see Japan Society of Business History[1964], pp. 334-336.

## 2. Zaibatsu and innovation

The same tendency is observed in innovation. In short, although the role of Zaibatsu is more important in modern industry, their role is less important in traditional industry. For example, in traditional industries such as food industry, wood manufacturing and so on, the individual patents ratio stood at a high level throughout the prewar period.[11] Although, moreover, individual patents for 'Agriculture (class 68 in a 1921 Classification)' which belongs to traditional industry, stood at 1,570 cases, corporate and government patents in class 68 stood at only 22 cases.[12] From my preceding analysis, it is clear that the trend of individual's inventions had no relation to the Zaibatsu.

Next, I would like to compare with several industries. Table 1 presents the list of corporations and government on photograph and camera, dry battery, internal combustion engine. Firstly, paying attention to the photograph and camera, the corporate and government patents stood at 304 cases amongst 1,724 patents on the whole. This was by no means a lot. The remainder were invented by individuals and foreign people. As for those enterprises, the most striking feature was that Konishiroku Headquarters filed 106 patents. Some other enterprises filed considerable number of patents as following: the Institute of Physical and Chemical Research 37 patents, Morita Corporation 21 patents, Tokyo Denki K.K. 21 patents, Oriental Photo Industry Co., Ltd. 18 patents, the Japan Optical Industry 13 patents and Asahi Photo Industry Ltd. 11 patents. Secondly, with regard to dry battery, 657 patents were approved, and 293 patents were filed by corporation and government, accounting for 45% of the whole. The battery enterprises filed plenty of patents. The details are following: Matsushita Electric Industrial Co., Ltd. 64 patents, Takasago Electric Industry Co., Ltd. 57 patents, Yuasa Battery Co., Ltd. 21 patents, Mitsubishi Electric Corporation 16 patents, NEC Corporation 15 patents, Okui Battery Co., Ltd. 15 patents, Japan Electric and Chemical Laboratory 15 patents, Toshiba Corporation 16 patents, Furukawa Electric Co., Ltd. and Japan Battery Co., Ltd. 10 patents. Particularly, of the Matsushita and Takasago were overwhelmingly powerful in research and development.

By the way, the trend for internal combustion engine was slightly different. Surprisingly, inventions filed in Japan stood at 237 of 300 cases of the whole. As you know, despite the fact that internal combustion was a brand new technology for the Japanese because it was imported from Western countries, that they made so much development upon the original invention was a very astonishing event. Looking into the 300 inventions in details, foreign companies were responsible for 39 patents, Japanese corporations and government were responsible for 100 patents (government for 15 patents), the remaining 161 patents were developed by individuals (19 patents were by foreign people). The number of Japanese corporate and government patents did not attain the number of individual patents, but made up one third of the whole. Certainly, this somewhat proves the modernity of this industry in those days because the more the modern industries perform the more organized research and development. The leading enterprises in combustion development were the following: Kobe Steel Ltd. 13 patents, Niigata Iron Works Co., Ltd. 10 patents, Tokyo Gas and Electric Corporation 9 patents, Mitsubishi Heavy Industry Ltd. 7 patents, Mitsubishi Shipbuilding Co., Ltd. 5 patents, Ikegai Iron Works

[11] See Guan [1999], Chapter 2 Figure 2-2.

[12] See references of the Patent Agency.

TABLE 1. COMPARISON OF INVENTION BETWEEN ZAIBATSU AND INDEPENDENT ENTERPRISES IN SELECTED INDUSTRIES

| Photograph and Camera | Dry Battery | Internal Combustion Engine |
|---|---|---|
| Konishiroku Headquarters[106] | Matsushita Electric Industrial Co , Ltd. [64] | Kobe Steel, Ltd.[13] |
| Institute of Physical and Chemical Research[37](RIKEN) | Takasago Electric Industry Co., Ltd.[57] | Chief of Aeronautic Laboratory[10] |
| Morita Corporation[21] | Yuasa Battery Co., Ltd[21](MITSUI) | Niigata Engineering Co., Ltd.[10] |
| Tokyo Denki K.K. [21] (MITSUI) | Mitsubishi Electric Corporation [16] (MITSUBISHI) | Tokyo Gas and Electric industries Co., Ltd [9](NISSAN) |
| Oriental Photo Industries Co., Ltd [18] | NEC Corporation[15] | Mitsubishi Heavy Industries Ltd.[7] (MITSUBISHI) |
| Japan Optical Industry Association [13] (MITSUBISHI) | Okui Battery Co , Ltd.[15] | Ministry of Navy[5] |
| Asahi Photo Industry, Ltd.[11] | Japan Electric and Chemical Laboratory [15] | Mitsubishi Shipbuilding Co., Ltd.[5] (MITSUBISHI) |
| Ichida & Co., Ltd [10] | Toshiba Corporation[15](MITSUI) | Ushimado Engineering Co., Ltd.[4] |
| Fuji Photo Film Co., Ltd.[8](MITSUI) | Furukawa Electric Co., Ltd. [10] (FURUKAWA) | Institute of Physical and Chemical Research[4](RIKEN) |
| Seihan Printing Co , Ltd.[6] | Ministry of Communication[10] | Ikegai Iron Works Ltd.[4] |
| Shimazu Corporation[4] | Japan Storage Battery Co., Ltd.[10] (MITSUBISHI) | Aichi Tokei Denki Co., Ltd.[3] |
| Zeo Studio[4] | Tokai Dry Battery Co., Ltd.[7] | Tohata Foundry Co., Ltd [3](NISSAN) |
| Photographic Science Laboratory[4] | Nippon Storage Battery Co , Ltd[5] | Hanshin Engineering Ltd.[3] |
| Tokyo Neon, Ltd.[3] | Asahi Battery Co., Ltd[5] | Nakajima Airplane Co., Ltd. [3] (NAKAJIMA) |
| Sendagi Corporation[3] | Okada Battery Co., Ltd.[4] | Hitachi, Ltd.[2](NISSAN) |
| Hardar Chemical Works Co., Ltd.[3] | Isomura Industry Co , Ltd[3] | Kawasaki Shipyards Ltd [2] |
| Saito Chemical Engineering, Ltd.[3] | Toho Chemical Laboratory[2] | Mitsubishi Electric Corporation (MITSUBISHI) |
| Ogi Industrial Trade Co.[2] | Oki Electric Industry Co., Ltd [2] (YASUDA) | Japan Motor Industry Co , Ltd |
| Sakurai Daijiro's Store[2] | Takehisa Dry Battery Co., Ltd[2] | Uraga Shipbuilding Co., Ltd. (SUMITOMO) |
| FDK Corporation[2](FURUKAWA) | Okada Electric Firm[2] | Motor Engineering Co.,Ltd. |
| Tokyo Bulb, Ltd.[2] | Tokyo Electric Co.[2](SUMITOMO) | Riken Anodized Aluminum Industry Co., Ltd.(RIKEN) |
| Mitsubish Shipbuilding Co., Ltd. (MITSUBISHI) | Toyo Electric Corporation [2] (MITSUBISHI) | Sakae-ya Asbestos looming Factory Co. |
| Jiji Press Co. | Chief of Tokyo Industrial Laboratory | Shibaura Engineering Works Co., Ltd. (MITSUI) |
| Yasutake Firms Co. | Tokyo Electric Corporation | Yokohama Shipbuilding Co., Ltd. (MITSUBISHI) |
| Akemi Dyeing Corporation | Kawanishi Works Co., Ltd. | Dai'ichi Engineering Co., Ltd |
| Osaka Roentgen Corporation | Nippon Battery Industry Co., Ltd | Kimoto Iron Works Co., Ltd. |
| Omoto Laboratory | Nicchitsu Chemical Industry Co., Ltd. (NICCHITSU) | Joint Corporation |
| Nippon Colorant Manufacturing Co., LtD. (SUMITOMO) | Ministry of Navy | Osaka Engineering Works Co., Ltd. |
| National Chemical Laboratory | Shimazu Corporation | Akiyasu Engineering Corporation |
| Hitachi, Ltd (NISSAN) | Taiwan Institute of Invention and innovation | |
| Dai-nippon Celluloid Co., Ltd (MITSUI) | Asahi Carbon Engineering Co., Ltd | |
| Sankyo Co., Ltd. | | |
| Ministry of Army | | |
| Kasahara Firms Co. | | |
| Takachiho Engineering Co , Ltd. | | |
| Goto Fuun-do, Ltd. | | |
| Mitsubishi Aircraft Co., Ltd. (MITSUBISHI) | | |
| Chief of Aeronautic Laboratory | | |
| Gunze Limited (MITSUI) | | |
| Toppan Printing Co., Ltd. | | |
| Shibaura Engineering Works Co., Ltd | | |
| Toyo Western Electric Industry Co., Ltd. | | |
| Total: 304 | Total: 293 | Total: 100 |

*Note:* 1) invention contains patents and utility models.

2) The range of data of photograph and camera, battery and combustion, by March of 1937, by1945 and from 1927 to 37, respectively.

3) Data of battery invention is only dealt with patents, not to be considered on utility models

4) [ ]: number of invention(no mark means 1 case), ( ): Zaibatsu concerned with.

*Sources:* Regarding data of photograph and camera, battery and combustion, see Tamura[1937], Miyazaki[1960] and Murayama[1939], respectively.

Ltd. 4 patents, the Institute of Physical and Chemical Research 4 patents, Ushimado Iron Works Co., Ltd. for 4 patents, Hanshin Iron Works Ltd. for 3 patents, Nakajima Airplane Co., Ltd. 3 patents, Aich Tokei Denki Co., Ltd. 3 patents, Kawasaki Shipyards Ltd. 2 patents and Hitachi, Ltd. 2 patents. As the preceding analysis shows, it is obvious that, most of these enterprises were deeply connected with Zaibatsu, or independent large enterprises.

From the indirect consideration above, I will present a suppositional judgement as follows: Modern industries were so deeply connected with Zaibatsu that their innovative activities were also affected by Zaibatsu (e.g. internal combustion engine). To the contrary, most traditional industries had no connection with Zaibatsu, so their innovative activities were not affected by Zaibatsu (e.g. farming tools). Industries which have neutral character, such as photograph and camera, dry battery, were affected by Zaibatsu to some degree, but the influence was not so strong.

### 3. Riken and innovation

The origin of Riken as an emerging Zaibatsu came with the establishment of Institute of Physical and Chemical research. Institute of Physical and Chemical research was a semi-governmental corporation established in 1917. The 3rd director, Masatoshi Okouchi emphasized the importance of interdisciplinary research methodologies in engineering on the basis of theoretical studies in Physics and Chemistry. Furthermore, he urged that the institute should slough off existing research initiatives where they had partiality toward Western technology, and instead it should independently develop original technology on the basis of the basic studies to which it was dedicated. In order to combine their academic outcomes with industrial promotion, he established Rikagaku Kogyo Enterprise Co., Ltd. in 1927. Rikagaku Kogyo Enterprise overcame its difficult initial stage by successfully not only producing, selling and mounting a temperature and humidity regulator to which applying moisture absorbent, but also selling products such as a sort of vitamin tablet and synthetic alcoholic beverages. When it improved its business performance in the process of Japanese business recovery after the Manchurian Incident, Okouchi decided to separate its experimental facilities from the body of the Enterprise, as he had planned therefore to do. On the other hand, he also induced smaller companies, which could be practically adapted for Rikagaku Kogyo's technologies, to be affiliated with the body of Rikagaku Kogyo. Consequently, the Enterprise formed a conglomerate, affiliating 23 directly controlled enterprises and 8 indirectly controlled enterprises. Furthermore, it rapidly expanded on the basis of metal industry and machine industry under the war regime in those days, then the group formed a complex of 58 enterprises in 1940.

Compared with other emerging Zaibatsu, as the scale of Riken was smaller than any other newcomer, so were its affiliated companies smaller than any others'. However, Riken's aim was not business activity alone, but commercialization and corporatization of its research outcomes, as well as acquisition of enough research funding through the commercialization and corporatization. In fact, it declined government subsidies from 1937. By the early of Showa era, consequently, Riken stood on firm financial ground, and its vigorous research activities materialized in thousands of published academic papers, and in the acquisition of Japanese/foreign patents. Lots of scientists of Riken won not only prizes such as the Japan Academy Award, the Order of Cultural Merit, but academic qualifications. In brief, Riken successfully produced excellent results in making its original research reach fruition while cultivation talent. Moreover, it not only produced plenty of approved patents in the field of applied studies, but industrialized feasible ideas and founded brand new enterprises thereby.[13]

Now I will present the number of inventions made by major national research organizations from the Taisho era onward. As National Electric Laboratory made 1,171 patents and 187 utility models, so did the Institute of Physical and Chemical Research make 905 and 133, respectively. Similarly, Tokyo Industrial Laboratory made 391 and 2, and Osaka Industrial Laboratory made 77 and 2, respectively. The Institute was ranked as the second most inventive organization.[14] Considering that the others were able to boast their longer history than Riken, research activities of the Institute produced as a splendid results.[15] Inevitably, I should say that Riken was the most successful example in the light of innovation and innovative application.

## IV. *Conclusion*

The following were found through the preceding examination: Firstly, Large enterprises frequently used capital-intensive technology, whereas smaller enterprises used labor-intensive technology. In other words, large enterprises and smaller enterprises in substituted capital for labor although they were under an identical system of production technology.

Secondly, despite the fact that large enterprises reaped more numerous fruits of innovation than smaller enterprises, numerically speaking, no positive proof was made with regard to accomplishment in innovation beyond that of scale. It should be stressed that smaller enterprises were, rather, more active in innovation than large enterprises. Accordingly, Schumpeter's Hypothesis is not supposed to be applicable to Japanese circumstances in prewar times.

Thirdly, innovative activity was vigorously made on both the monopolistic market and the competitive market. Traditional industry was formed by innumerable smaller enterprises which strove to innovate under fiercely competitive markets. On the contrary, modern industry was formed by a few large enterprises which strove to innovate under monopolistic market conditions.

Fourthly, the role which Zaibatsu played in technology importation and innovation in modern industry was inevitably significant. Compared with the existing Zaibatsu, moreover, the emerging Zaibatsu played a more active role. Particularly, Riken was a good example of the success of the new Zaibatsu.

Comprehensively considering the preceding argument, it is likely that the Schumpeter's Hypothesis was not always valid in respect of the realities of prewar Japan. Owing to the fact that traditional industry formed by smaller enterprises had huge share in the existing "dual structure", its innovative activities were not less vigorous than those of modern industry formed mainly by large enterprises. Consequently, I should note that the Ohkawa?Rosovsky Hypothesis' validity is only to the case of modern industry.

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[13] For research regarding emerging Zaibatsu and Riken, see Udagawa[1984], Saito[1987].

[14] MITI, *op. cit.*, p.518.

[15] The National Electric Laboratory is the oldest research organization (established in 1891), as well as National Institute of Geology. Also, the Tokyo Industrial laboratory was established in 1900.

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