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A STUDY IN THE INDEX NUMBERS OF THE BANK OF JAPAN

1.

The phrase "learning by doing" is a favourite expression of those economists who believe that observing various economic phenomena is the best way to study economics; and the phrase may be used in dealing with price-index numbers. While it is quite possible to conceive an abstract index number, the other method is to observe actual index numbers in a given place and time, and to study how they can be developed. I herein adopt the latter method in making a study of the question of index numbers as it actually exists in Japan.

In the recent years a great development has taken place in both the number and content of index numbers in this country, due mainly to great fluctuations in the prices of commodities since the World War. I shall herein deal with the index numbers of wholesale prices, of retail prices and of the cost of living.[1] The index numbers of wholesale prices are formed by the following organizations and concerns: the Bank of Japan, the Chambers of Commerce of Tokyo, Osaka and Kyoto, the Ministry of Commerce and Industry, the Osaka Asahi Shimbun (Osaka daily), the Toyo Keizai Shinpo Sha, and the Diamond Sha. The index numbers of retail prices are formed by the following organizations: the Bank of Japan, the Chambers of Commerce of Tokyo, Osaka and Kyoto and the Social Bureau of the Home Department. As to the index numbers of the

[1] For the characteristics of each of these index numbers, see my "Indexzifferberechnung in Japan." (Weltwirtschaftliches Archiv Bd. XXII)

cost of living in Japan, that which is made by Dr. Takano[2] is so far the only complete one, others being only fragmentary and incomplete. Of the foregoing index numbers of prices, by far the most representative one is that of the Bank of Japan, and I shall chiefly deal with this one.

The index numbers of the Bank of Japan are the following three: the old index number of wholesale prices (January, 1887=100, forty-four commodities, the simple arithmetic averages); the new index number of wholesale prices; and the index number of retail prices (October, 1900 =100 and July, 1914=100, one hundred commodities, the simple arithmetic averages). Of these, the old index number of wholesale prices was abandoned about ten years ago, while the index of retail prices was issued comparatively recent and is not regarded as important. When, therefore, people speak about the index number of the Bank of Japan, they usually mean the new index number of wholesale prices. I shall hereafter deal with this index number.

2.

The index number of wholesale prices formed by the Bank of Japan is based upon the wholesale prices of 56 commodities in Tokyo and is announced every month in a pamphlet called the "Index Number of Average Monthly Wholesale Prices in Tokyo."

The recent index number of the Bank of Japan (Price Index for February, 1926) is as follows:

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[2] "*The cost of living of 20 workers in Japan.*" (東京に於ける二十職工家計調査)

Index Number of Average Monthly Wholesale Prices in Tokyo.

February, 1926.

The Bank of Japan,

Tokyo, Japan.

Price Index for February, 1926. (Oct. 1900=100)

Commodities	Feb.	Inc. or Dec. on Last Month	Inc. or Dec. on Last Year	Commodities	Feb.	Inc. or Dec. on Last Month	Inc. or Dec. on Last Year
Rice	324	+ 4	− 11	Cotton	171	−14	−65
Barley	295	−10	− 80	Ramie & china grass	293	×	−11
Naked barley	298	− 1	−130	Worsted yarn	271	−17	(−97)
Wheat	280	−14	− 49	Mousseline	191	− 5	−63
Soja beans	238	− 5	− 21	Woollen cloth	265	− 4	(−23)
Azuki (Red or white beans)	285	−18	−156	Indigo	180	×	−11
Wheat flour	278	− 5	− 46	Timber	229	+ 3	−21
Ammonium sulplhate	162	− 5	(− 5)	Steel, bars & rods	113	− 3	−16
Fish fertilizer	221	− 8	×	Nails	128	×	−18
Oil cake	235	− 1	− 7	Copper	133	− 2	−17
Sugar	280	+ 2	− 46	Lead	209	− 8	(−39)
Tea	346	×	×	Stone	368	+ 2	−18
Salt	336	−11	− 43	Bricks	272	×	×
Miso	477	×	+ 13	Tiles for roofing	218	×	−31
Soy	185	− 5	− 10	Portland cement	138	×	− 9
Sake	214	×	− 6	Mattings	281	− 1	−28
Katsuobushi (Dried bonito)	481	−14	− 73	Glass-plates	173	− 4	−29
Eggs	162	−41	− 26	*Kami* (Japanese paper)	396	×	+ 6
Beef	404	×	(+ 19)	Paper	225	×	−26
Oil	205	−11	− 51	Caustic soda	168	− 3	(−21)
Cigarettes	297	×	+ 51	Leather	325	− 4	−46
Raw silk	240	− 8	− 31	Matches	223	×	−16
Habutaye silk	178	− 2	− 11	Coal	287	− 1	−38
Silk-hand-kerchiefs	206	−11	− 13	Kerosene oil	305	+ 9	−30
Kaiki silk	147	− 3	×	Charcoal	266	− 5	− 7
Silk for lining	218	− 1	− 9	Fuel wood	256	− 7	− 3
Floss silk	218	− 4	+ 2				
Cotton yarn	276	−16	− 90				
Imitation nankeens	186	−22	− 45				
Cotton shirtings	201	− 6	− 66	**Average**	**249.23**	**−5.00**	**−28.63**

The numbers of the commodities, the prices of which rise (+), fall (−) or do not change (×) compared to the prices of the last month, are 5, 37 or 12 respectively.

Index number for February, 1926 as percentages of varying basic figures.

Jan. 1926=100	Feb. 1925=100	Feb. 1924=100	Feb. 1923=100	Feb. 1922=100	July, 1914=100
98.03	89.70	90.69	98.18	92.46	198.19

Price Movement in the last ten years (Jan. 1917—Feb. 1926).

Movement of prices for principal commodities (Rice, Wheat, Sugar, Raw silk, Cotton yarn, Timber, Steel, Copper, Paper and Coal) **in the last twelve months.**

Comparative Wholesale Price Levels in Principal Countries (Tokyo; The Bank of Japan. London; Economist. New York; Bradstreet's. Paris; Statistique Générale) (July, 1914=100).

There has been much change in the 56 commodities in the index number of the Bank of Japan in the recent years. Until June, 1925, rice bran, tobacco, flannel, Italian cloth, lacquer and vegetable wax were included among the 56 commodities, but after that time, they were replaced by the following commodities: ammonium sulphate, beef, worsted yarn, woollen cloth, lead and caustic soda. Each commodity has its own basic brand and the monthly price of a certain quantity is taken as the material of the index number.[3] First the index number of each commodity is ascertained. The price of each commodity in October, 1900 is taken as 100 and the price of each month is expressed in percentage. Next the average price per unit paid for each commodity in each successive month is ascertained and finally the sum of these unit prices in each of a num-

[3] Regarding this point see my work previously mentioned.

ber of successive months is taken as the index number. The so-called Bank of Japan's index number of wholesale prices refers to this sum of unit prices.

There are several points which should be taken up separately in making a study of the Bank of Japan's index number. The first point is the basic materials by which the index number is to be formed. Articles and their brands should be first determined upon. The second point is the base time. The third point is the method by which the sum of unit prices is arrived at. I shall take them up in turn.

The selection of a list of basic articles of particular brands, whose prices are to be taken into account, is the first and the most important step in the formation of an index number. As they are intended to be the basic articles of a country, they must be sufficient and necessary to reflect on the prices of the country. And the brands to be selected should be the proper representatives of the articles.

Although it is not known what method or standard was adopted by the Bank of Japan in selecting the list of articles and their brands in 1900, but I may suppose that the selection was made by the economic experts of the country, the articles actually selected must have had a sufficient reason to be chosen. However, it must be supposed that the significance of articles in the national economy of a country changes whith a change of times, so that the goods which are necessary for the life of a nation at one time cease to be so at another time. Moreover, it is possible that some of the basic articles were not included in the original list of 56 commodities, and that the commodities of basic brands are not included among the present list. This point should never be overlooked in our present inquiry, inasmuch as the economic world of our country has undergone a phenomenal change during the past forty or fifty years. Nay, it may be asserted, though with some measure of extremity, that just because those commodities were selected as basic articles some twenty-five years ago,

they can be regarded as otherwise at present. This difficulty is not limited to the index number of the Bank of Japan, but is true of all others. The usual remedy is to replace the old brands by similar ones. The question is where to find special brands which assure the preservation of the homogeneity of commodities.

There are two typical cases of the homogeneity of commodity brands. Where the economic circumstances are fixed or where there is no big economic change, the homogeneity of commodity brand will be preserved by taking a per unit quantity of a commodity of a certain brand. But where the economic factors greatly fluctuate, this homogeneity can be best preserved by taking different brands in accordance with the nature of economic changes. At any rate, the homogeneity in question can never be preserved where economic factors constantly shift, by continuing to take commodities of the same brand for any long period of time. However, it is almost impossible continuously to change the brands in accordance with the changes in the economic circumstances, without giving rise to abrupt hitches and dislocations at the times of changes, because of the insufficient development in the economic statistics of our country. This makes the matter more complicated than ever. It will be seen that the index number of the Bank of Japan, like all other index numbers, also can be the object of criticism. It is wellnigh impossible to decide properly as to what commodities should be taken out from or should be added to, the existing list and what particular brands should be replaced by or added to it.

The second important factor in the construction of an index number is the basing period. Although the basing period has a close relationship with the formation of averages, it can be treated separately.

If the basing period is regarded as the starting point of the index number, the basing time should be fixed either at the first of the years to be studied or at the time at which the prices are lowest. On the contrary, if the basing

time is regarded as the terminus of the index number, it should be fixed either at the last of the years to be studied or at the time at which the prices are highest. But the basing period is usually fixed at the time of normal prices. Thus the basing period should occupy the central point, the price being represented by 100, so that other prices may be arranged in a proper way. When this is kept in the mind, a doubt springs up as to the wisdom of fixing the basing time of the Bank of Japan's index number at October, 1900.

The third factor in the formation of an index number is the methods of calculating the sum of the specific prices, namely, averaging and weighting. As Irving Fisher[4] has already made a thorough study of these methods, I shall not dwell upon them herein.

The index number of the Bank of Japan deals with the simple arithmetic averages of the price units of 56 selected commodities. Since the simple averages are adopted, the 56 commodities are treated on the same level and weighted in the same way. It can be said that they are not weighted at all. The question of weighting is closely connected with the selection of basic commodities. A defect from the absence of weighting can be remedied to some extent by the selection of basic commodities, while that of the latter can be retrieved by the former. Again, the question of weighting, like that of the basic commodities, is difficult of solution. I am convinced that the weighting which suited requirements in October, 1900, does not fit in at the present. The question of what particular method of weighting should be adopted to suit the ever-chaning economic phenomena is indeed a baffling question.

So far I have pointed out the principal questions concerning index numbers which are dealt with by other writers. But I wish to throw some light upon the questions of dispersion and skewness by going deeper into the

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[4] Fisher, "Making of Index Numbers."

index numbers. I also wish to explain our economic development from the time of the adoption of the gold standard until the great earthquake of 1923. However, it is far from me to attempt to solve all the questions involved. As I have already stated, it is impossible to get hold of statistics upon which a study of the basic commodities and brands can be based, and for this reason I shall not take up that question. I shall also refrain from investigating the question of weighting because of the same reason. I intend to study the following: first, the question of fixing the basing period and the method of averaging unit prices; secondly, the dispersions and skewnesses of specific commodities, classified commodities and the general index numbers; and thirdly, the range of price variations.

3.

As I have already stated, the index number of the Bank of Japan fixes the basing time at October, 1900 and the general index number is constructed by taking the simple arithmetic averages of 56 basic commodities. This gives rise to the questions of the proper basing time and the method of averaging.

Usually the one year average, five year average and ten year average are adopted as basing periods. As the prices during any given month may be due to some special circumstances, those longer periods are usually adopted. The ten year average is particularly adopted because of the view among some that a trade prosperity cycle occurs once in every ten years. I am, therefore, convinced that the month of October, 1900, which is fixed as the basing time by the index number of the Bank of Japan, is not proper. If we examine the index numbers during the period between October, 1900 and July, 1923, we find the following extreme cases:

The totals lower than the index number of October, 1900 (100) (during 274 months).

1. Leather (0), paper (0), sugar (5), vegetable wax (5).

2. Steel, bars and rods (170), *habutaye* silk (168), *kaiki* silk (160), nails (150).

The following are the geometric averages of the specific commodities during 274 months (October, 1900=100):—

1. Sugar (223.39), salt (216.32), red beans (197.54), *miso* (183.02).

2. *Habutaye* silk (103.75), copper (110.50), *kaiki* silk (111.72), rice bran (118.67).

Thus it will be seen, that, while such things as leather and paper always show numbers which are higher than that of the basing time, there are on the other hand steel, bars and rods as well as *habutaye* silk which show numbers lower than that of the basing time, over 60 % of the whole period of time above mentioned. Also we must not forget the fact that the prices of sugar and salt were doubled during 274 months, while that of *habutaye* silk remains practically the same. At any rate the basing period selected does not fit in all cases. The month of October, 1900, should be remembered as the time of the adoption of the gold standard, but it is not an ideal basing time.

What method is adopted in fixing the basing period makes a great difference when an arithmetic average is adopted in the formation of index numbers of price quotations. We shall show this by an example. Let us take the following three basic commodities: rice, wheat and iron. Whether we fix March or May as the basing point will make a great difference, as the following Table will show:

Commodity	March	April	May	March	April	May
Rice	100	50	20	500	250	100
Wheat	100	120	160	63	75	100
Iron	100	150	200	50	75	100
Arithmetic Averages	**100**	**107**	**127**	**204**	**133**	**100**

Thus by changing March to May as the basing time,

not only the general index numbers change (the absolute number of +27 changes to −104, while the relative number +27% changes to −51%.), but also the direction of the variation of index numbers changes from upward (+) to downward (−). The example cited is an extreme one, of course, but it shows what difference a change in the basing time might make, as the example of the Bank of Japan's index number indicates. However, this can be remedied to a certain extent by the adoption of geometric averages. Fisher's "time reversal test" deals with this problem.

I shall next explain the method I used in connection with my present investigation. As the price quotations in the period from October, 1900 to July, 1923 are the materials for the present inquiry, I have taken the geometric average of the price quotations of the entire period (274 months) and called it 100. I have then weighted the prices of the basic commodities as follows: rice (157.94), wheat (151.87), sugar (223.39), salt (216.32), *sake* (142.93), cigarretes (157.19), raw silk (142.17), *habutaye* silk (103.75), cotton yarn (170.69), steel (119.99), copper (110.50), coal (165.60), timber (134.54), paper (158.39) etc. With the geometric average of each of these commodities I have divided the price index of the same commodity, and then multiplied the quotient by 100. I have repeated this method about 56 commodities in the period of 274 months. Thus my method is based upon the whole quotations of 23 years.

I have then constructed the general index number by taking the simple geometric average of these revised index numbers of 56 basic commodities and found the geometric average of each successive month. I have secured the following table (Table 1.):—

In order to show how my revised index number differs from that of the original form, I shall present Table 2:—

When the Bank of Japan adopted the month of October, 1900 as the basing time, it was trying to measure changes in the prices of other months by specifying the price quotation of a fixed month. On the contary I attempt

Table 1.

The Revised Bank of Japan's General Index Number of Wholesale Prices

Year	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
1900	—	—	—	—	—	—	—	—	—	68.73	68.73	68.66
1901	68.24	67.24	65.87	64.46	64.10	64.28	65.01	65.92	66.68	67.57	65.23	64.65
1902	64.13	**64.87**	**64.85**	64.75	65.17	65.65	66.14	66.98	67.34	**67.20**	**67.14**	67.58
1903	68.15	68.59	**69.46**	**69.61**	69.77	69.61	69.88	69.73	**70.43**	**70.42**	69.79	69.36
1904	70.97	72.72	72.46	71.91	71.32	70.52	70.13	71.79	74.03	75.20	**75.33**	75.26
1905	74.84	74.99	75.54	76.30	77.40	78.33	79.67	80.01	79.87	79.82	80.07	79.89
1906	80.31	79.96	79.70	78.98	78.53	78.94	79.31	79.64	80.88	82.50	83.03	83.57
1907	84.96	85.41	85.62	86.08	86.17	85.96	85.49	86.70	**90.27**	**89.38**	89.25	88.44
1908	87.59	86.56	85.33	84.66	83.99	**82.75**	**82.90**	83.00	83.09	82.44	81.32	79.50
1909	79.23	79.70	79.25	79.18	**79.58**	**79.75**	79.73	79.91	80.04	79.25	78.27	78.41
1910	79.43	79.84	80.35	80.42	80.62	80.43	80.09	80.32	81.67	82.15	82.24	82.25
1911	82.47	**82.52**	**82.48**	82.38	82.72	81.56	81.70	83.50	85.50	85.21	84.53	84.97
1912	86.04	86.59	87.12	87.67	87.92	87.53	88.34	87.39	87.14	87.99	88.25	88.79
1913	88.75	87.95	**87.63**	**87.68**	87.33	87.68	86.93	86.83	88.28	88.93	88.08	87.31
1914	86.57	85.85	85.29	85.00	83.32	83.84	83.68	84.73	85.65	83.49	80.61	79.33
1915	79.86	81.81	82.73	83.83	84.26	83.34	82.37	82.86	83.03	83.79	87.26	91.47
1916	93.59	97.10	97.88	97.60	96.14	94.76	95.79	98.57	100.31	103.23	110.71	113.34
1917	110.96	109.56	109.76	113.30	118.92	125.10	135.06	143.65	**139.99**	**140.80**	140.12	142.91
1918	146.87	152.61	156.02	**158.96**	**159.20**	161.11	165.27	174.73	179.77	183.82	182.94	**182.30**
1919	**181.72**	179.96	174.51	174.73	181.78	193.02	208.13	213.19	219.36	231.93	243.44	253.28
1920	263.16	273.84	279.52	260.09	233.00	212.16	205.15	201.03	198.27	195.37	192.21	177.96
1921	173.58	168.48	164.60	164.15	165.59	166.82	170.82	172.84	179.49	189.84	186.33	181.57
1922	179.02	177.20	174.41	171.43	168.57	171.77	174.83	169.81	167.51	165.18	163.27	159.33
1923	162.48	168.20	**171.79**	**171.62**	174.00	173.00	167.64	—	—	—	—	—

Table 2.

The Unrevised General Index Number of the Bank of Japan

Year	Jan.	Feb.	Macrh	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
1900	—	—	—	—	—	—	—	—	—	100.00	100.09	100.00
1901	99.46	98.09	96.18	94.23	93.70	93.98	94.98	96.30	97.38	97.02	95.43	94.84
1902	93.91	**95.09**	**95.18**	95.14	95.68	96.43	97.07	98.48	98.86	**98.48**	**98.66**	99.80
1903	100.59	101.75	**103.14**	**103.07**	103.39	103.30	103.59	103.34	**104.18**	**104.36**	103.43	102.96
1904	105.88	108.98	108.36	107.61	106.50	104.98	104.75	106.89	110.25	111.77	112.20	112.16
1905	111.55	111.68	112.59	113.52	115.27	117.11	118.80	119.38	119.07	119.02	119.23	119.13
1906	119.70	119.16	118.88	117.80	117.09	117.52	118.05	118.55	120.34	122.57	123.07	124.21
1907	126.21	127.02	127.30	128.07	128.29	127.82	127.00	128.77	**132.82**	**134.23**	132.64	131.30
1908	130.27	128.95	127.27	126.39	125.52	**123.59**	**123.38**	123.50	123.57	122.59	121.07	118.48
1909	118.18	119.18	118.79	118.77	**119.46**	**119.45**	119.32	119.57	119.68	118.38	116.98	117.30
1910	117.70	118.86	119.84	119.88	120.27	119.63	118.89	120.43	121.59	121.98	121.98	122.57
1911	123.30	**123.57**	**123.59**	123.36	123.84	122.25	122.38	124.93	128.09	127.52	126.41	127.18
1912	129.14	130.36	131.27	132.45	133.04	131.95	133.64	131 77	130.95	132.30	133.23	134.77
1913	134.59	133.04	**132.59**	**132.38**	131.86	132.29	130.63	130.30	132.52	133.71	132.53	131.34
1914	130.18	128.98	128.14	127.71	125.11	125.86	125.75	127.68	129.16	125.73	121.56	119.81
1915	120.64	123.66	125.32	127.36	128.37	127.11	125.63	126.27	126.29	127.59	133.07	141.75
1916	145.36	153.46	154.92	153.92	150.34	147.16	147.66	151.07	153.11	157.16	168.34	172.39
1917	168.61	166.57	167.35	173.09	182.09	190.41	206.26	221.51	**214.13**	**214.09**	212.92	216.96
1918	224.02	232.80	238.73	**243.33**	**242.75**	245.28	252.19	267.50	274.84	280.26	278.20	**277.38**
1919	**277.73**	275.93	267.51	267.94	278.16	295.42	319.73	324.61	332.88	352.14	370.16	381.50
1920	398.00	414.59	425.25	397.25	359.70	327.68	316.63	311.04	304.96	298.45	292.73	271.98
1921	265.84	257.95	252.98	251.14	252.66	253.93	259.82	263.52	273.50	289.84	283.29	276.95
1922	272.48	269.55	265.50	261.25	257.00	261.02	266.04	258.32	255.23	252.02	248.63	241.77
1923	243.71	523.86	**259.00**	**259.46**	263.32	261.61	254.52	251.84	278.09	279.91	277.88	278.54
1924	278.96	274.82	272.09	273.36	271.11	263.95	258.89	264.75	273.14	281.75	283.57	282.45
1925	282.71	277.86	270.32	266.86	263.75	264.43	262.36	264.79	266.11	265.14	261.46	256.23
1926	254.23	249.23	243.89	238.91	—	—	—	—	—	—	—	—

to find the average of the price quotation of the entire months and take this average as 100. In this way I wish to see what percentage each price index occupies in the whole index number. In other words, I wish to clarify the relation existing between the whole and parts. Instead of observing the continuously changing economic phenomena from the fixed viewpoint, I am attempting to explain the relation existing between the whole (which is abstracted from the various changing phenomena) and each of these phenomena. My study has brought forth different results in more than ten months with regards to the directions of the changes in prices. (These months are: March and November, 1902; April and October, 1903; October, 1907; July, 1908; June, 1909; March, 1911; April, 1913; October, 1917; May, 1918; January, 1919; April, 1923.) Also there are many differences in the degrees of changes.

4.

I shall now take up the questions of the dispersion and skewness of the index numbers. Of various characteristics of the index numbers, their averages are the simplest. The index number of rice, for instance, can be shown by its geometric average 157.94. But it will be seen that both the arithmetic average of 158.94 and 156.94 and that of 300.94 and 14.94 are 157.94. The variation or scattering of the observations in the former case is wider than that of the latter. This constitutes the question of dispersion.

I shall now show an example, in which two index numbers are the same with respect to their averages but their dispersions are different. The illustrations I and II of Fig. 1 show the index numbers of two commodities, respectively sugar and vegetable wax, which have the same averages in 274 months.[5] The illustrations I and II have the same

[5] On the horizontal line the index number of individual commodities are given on logarithmic scale; on the vertical line numbers showing index are given on natural scale.

geometric averages but the dispersion of sugar is larger than that of vegetable wax. Whereas the former's minimum is 40.29 (logarithm 1.6051846) and its maximum is 311.12 (logarithm 2.4929287), the latter's minimum is 53.96 (logarithm 1.7320790) and its maximum, 209.72 (logarithm 2.3216487). In analyzing the index numbers, it is necessary to study not only averages but dispersions as well.[6]

Fig. 1

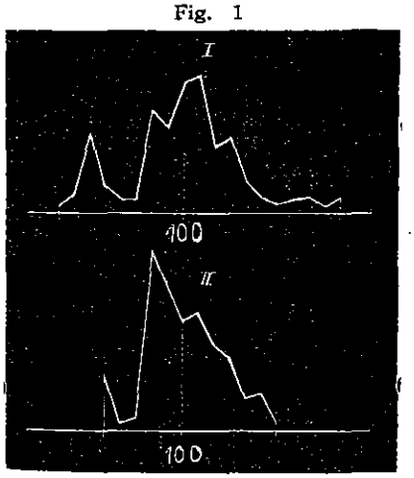
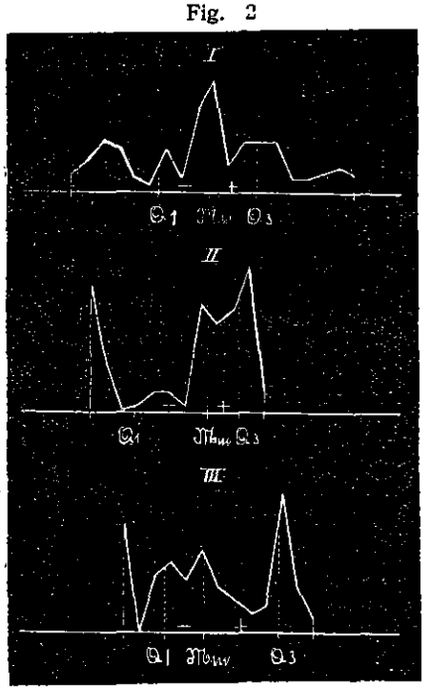


Fig. 2



Even supposing the averages and dispersions of two index numbers are the same, the question remains as to whether there is symmetry or whether the dispersion is a positive asymmetry or a negative asymmetry. I have set forth the specific index numbers of cotton yarn, coal and paper during the period between August, 1914 to July, 1923, in order to show that, although the dispersions of different index numbers are alike, their asymmetries may

[6] Prof. Takarabe, "*The Outline of Social Statistics*," pp. 329–330. (社會統計論綱)

be different.[7] The illustration I of Fig. 2 (cotton yarn) shows a case in which symmetry exists; the illustration II (coal) indicates a negative asymmetry; the illustration III (paper) shows a positive asymmetry.

There are various methods for the measurement of the dispersion and asymmetry. Following Bowley's method, I have calculated quartile deviation $\left(\frac{Q_3-Q_1}{2}\right)$ and skewness from quartiles[8] $\left(\frac{Q_3+Q_1-2Q_2}{Q_3-Q_1}\right)$. As a supplementary to Bowley's quartile deviation, I have calculated $\frac{\log Q_3-\log Q_1}{2}$ and to his skewness I have made an addition $\frac{\log Q_3+\log Q_1-2\log Q_2}{\log Q_3-\log Q_1}$. For, in order to understand the relations existing between different index numbers, dispersion and skewness based upon the ratio of variation are more desirable than those based upon absolute numbers. I have also calculated upper quartile, lower quartile, median, maximum, minimum, upper decile and lower decile, all of which are necessary materials for understanding the quartile deviation and skewness from quartiles. A study of these things results in the clarification of the different types of index numbers.

First I selected 14 basic commodities as the representatives of cereals (rice and wheat), food stuffs (sugar and *sake*), fine textiles (raw silk, *habutaye* silk and cotton yarn), metals (steel and copper), fuels (coal), building materials (timber), special manufactures (paper) and government monopoly (cigaratte and salt), in order to study their dispersions and skewnesses.

The Table 3 showing the index numbers of 14 basic commodities follows.

The foregoing figures indicate that in quartile deviation, coal comes first, followed by: paper, cotton yarn, steel (bars and rods), rice, timber, *habutaye* silk, raw silk, sugar,

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[7] On the horizontal line the index numbers of commodities are given on logarithmic scale; on the vertical line numbers showing index are given on natural scale.

[8] Bowley, "Elements of Statistics" pp. 113. 116.

Table

The Dispersions and Skewnesses of Index Numbers

Commodity	Maximum	Upper decile	Upper quartile	Median
Rice	292.51	206.41	**126.63**	**84.84**
Wheat	247.57	171.19	**123.79**	**90.86**
Sugar	311.12	157.57	**125.34**	**100.72**
Salt	194.62	162.26	**128.05**	**112.80**
Sake	244.87	174.91	**111.24**	**91.65**
Cigarette	156.50	156.50	**104.33**	**101.79**
Raw silk	365.77	169.52	**121.69**	**85.11**
Habutaye silk	316.16	165.79	**127.23**	**85.79**
Cotton yarn	437.64	220.28	**142.95**	**82.61**
Steel	494.23	243.36	**133.35**	**72.51**
Copper	180.08	149.31	**121.26**	**95.92**
Coal	268.11	233.09	**181.76**	**80.92**
Timber	335.21	242.30	**124.87**	**82.50**
Paper	394.59	308.10	**154.05**	**71.34**

Table

The Dispersions and Skewnesses of Index Numbers

Commodity	Maximum	Upper decile	Upper quartile	Median
Rice	124.73	112.70	**91.17**	**78.51**
Wheat	102.05	69.79	**90.86**	**86.26**
Sugar	120.87	106.54	**97.14**	**84.16**
Salt	129.90	123.66	**116.49**	**110.02**
Sake	100.04	96.55	**92.35**	**86.75**
Cigarette	104.33	104.33	**101.79**	**85.25**
Raw silk	129.43	92.85	**85.82**	**80.19**
Habutaye silk	108.92	9[illegible]39	**87.72**	**80.97**
Cotton yarn	100.18	91.39	**84.95**	**78.51**
Steel	83.34	76.68	**70.84**	**67.51**
Copper	138.46	103.16	**96.83**	**85.06**
Coal	94.80	85.14	**80.92**	**77.29**
Timber	95.14	83.99	**82.30**	**78.78**
Paper	71.34	71.34	**67.55**	**67.55**

3.

of Commodities (From October, 1900 to July, 1923)

Lower quartile	Lower decile	Minimum	Quartile deviation	Skewness from quartiles	Logarithm	
					Quartile deviation	Skewness from quartiles
72.81	65.21	56.98	26.91	+0.553	**0.1202**	**+0.447**
81.65	69.14	54.65	21.07	+0.563	**0.0904**	**+0.486**
80.58	51.03	40.29	22.38	+0.100	**0.0959**	**−0.010**
98.46	42.99	33.75	14.80	+0.031	**0.0571**	**−0.034**
82.55	73.46	62.27	14.35	+0.366	**0.0648**	**+0.299**
83.97	62.98	59.16	10.18	−0.750	**0.0471**	**−0.772**
78.08	75.27	64.71	21.81	+0.677	**0.0964**	**+0.611**
78.08	74.22	66.51	24.58	+0.686	**0.1060**	**+0.614**
70.89	62.69	55.66	36.03	+0.675	**0.1523**	**+0.564**
66.67	62.51	57.51	33.34	+0.825	**0.1505**	**+0.758**
79.64	76.92	64.25	20.81	+0.217	**0.0913**	**+0.115**
76.69	59.78	48.31	52.54	+0.920	**0.1874**	**+0.876**
75.07	66.89	61.69	24.90	+0.701	**0.1105**	**+0.629**
67.55	66.29	62.13	43.25	+0.912	**0.1790**	**+0.868**

4.

of Commodities (From October, 1900 to July 1914)

Lower quartile	Lower decile	Minimum	Quartile deviation	Skewness from quartiles	Logarithm	
					Quartile deviation	Skewness from quartiles
70.28	63.31	56.98	10.45	+0.212	**0.0565**	**+0.149**
75.72	62.55	54.65	7.57	−0.392	**0.0396**	**−0.429**
59.99	49.69	40.29	18.58	−0.301	**0.1047**	**−0.405**
46.69	40.22	33.75	34.90	−0.815	**0.1985**	**−0.875**
76.96	68.56	62.27	7.70	−0.272	**0.0396**	**−0.314**
64.25	62.34	59.16	18.77	−0.119	**0.0999**	**−0.229**
77.37	75.26	66.12	4.23	+0.333	**0.0225**	**+0.310**
76.15	73.26	66.51	5.79	+0.167	**0.0307**	**+0.132**
66.79	61.52	55.66	9.08	−0.291	**0.0522**	**−0.344**
65.01	60.84	57.51	2.92	+0.142	**0.0187**	**+0.122**
77.83	76.02	64.25	9.50	+0.239	**0.0474**	**+0.186**
62.80	57.37	48.31	9.06	−0.599	**0.0550**	**−0.638**
70.61	63.92	61.69	5.95	−0.374	**0.0338**	**−0.408**
66.29	64.40	63.13	0.63	−1.000	**0.0041**	**−1.000**

copper, wheat, *sake*, salt and cigarettes (in the given order). In skewness, also coal (+0.876) comes first, followed by: paper, cigarettes, steel, (bars and rods), timber, *habutaye* silk, raw silk, cotton yarn, wheat, rice, *sake*, copper and salt (−0.034). The foregoing figures are a minutia of the economic changes which took place in our country during the time between the adoption of the gold standard and the great earthquake of 1923.

Since the extraordinary event of the World War occurred during the 23 years, we must divide the whole period into two parts, the first of which is the period between October, 1900 and July, 1914.

Table

The Dispersions and Skewnesses of Index Numbers

Commodity	Maximum	Upper decile	Upper quartile	Median
Rice	292.52	256.43	**208.31**	**150.06**
Wheat	247.57	201.48	**175.80**	**142.22**
Sugar	311.12	341.73	**159.81**	**135.19**
Salt	194.62	179.36	**162.26**	**138.68**
Sake	244.87	216.18	**181.20**	**131.53**
Cigarette	156.50	156.50	**156.50**	**121.51**
Raw silk	365.77	211.02	**170.93**	**138.57**
Habutaye silk	316.16	201.46	**166.76**	**139.77**
Cotton yarn	437.64	318.71	**221.46**	**156.42**
Steel	494.23	358.38	**246.70**	**184.19**
Copper	180.08	161.99	**149.32**	**128.50**
Coal	268.11	252.41	**236.11**	**189.01**
Timber	335.21	257.16	**242.30**	**155.34**
Paper	394.59	334.61	**308.09**	**180.56**

The Table 5 indicates that in deviation timber leads the list with 0.2152, followed by the following by: rice, paper, coal, cotton yarn, steel, *sake*, wheat, salt, *habutaye* silk, raw silk, cigarettes, copper and sugar (0.0688). In skewness paper with its +0.296 comes first, followed by

The Table 4 follows:

The Table 4 shows that in quartile deviation, salt with its 0.1985 leads the list, then come the following in the order given: sugar, cigarettes, rice, coal, cotton yarn, copper, wheat, *sake*, timber, *habutaye* silk, raw silk, steel and paper (0.0041). In skewness, raw silk with its +0.310 leads the list, then come copper, rice, *habutaye* silk and steel, after which − is reached; then come the following in the order given: cigarettes, *sake*, cotton yarn, sugar, timber, wheat, coal, salt and paper (−1.000).

The Table 5 shows the index numbers of the period between August, 1914, and July, 1923, as follows:

5.

of Commodities (From August, 1914 to July, 1923)

Lower quartile	Lower decile	Minimum	Quartile deviation	Skewness from quartiles	Logarithm	
					Quartile deviation	Skewness from quartiles
85.48	69.65	61.42	61.42	−0.052	**0.1934**	**−0.264**
103.37	89.55	75.06	36.22	−0.073	**0.1153**	**−0.202**
116.39	109.68	103.86	21.71	+0.134	**0.0688**	**+0.055**
98.46	97.08	96.15	31.90	−0.261	**0.1084**	**−0.371**
93.75	86.05	67.16	43.73	+0.136	**0.1430**	**−0.028**
104.33	104.33	104.33	26.09	+0.341	**0.0880**	**+0.248**
110.43	74.56	64.71	30.25	+0.070	**0.0949**	**−0.039**
104.10	74.22	69.40	31.33	−0.139	**0.1023**	**−0.251**
108.97	68.55	55.66	56.25	+0.156	**0.1540**	**−0.020**
122.51	108.35	75.01	62.10	+0.007	**0.1520**	**−0.165**
104.07	94.11	77.83	22.63	−0.080	**0.0784**	**−0.168**
111.11	79.71	76.69	62.50	−0.246	**0.1637**	**−0.410**
89.93	75.81	74.33	76.19	+0.141	**0.2152**	**−0.103**
135.11	74.50	74.50	86.49	+0.475	**0.1790**	**+0.296**

cigarettes and sugar (after which − is entered into), cotton yarn, *sake*, raw silk, timber, steel, wheat, *habutaye* silk, rice, salt and coal (−0.410.)

Generally speaking, deviation has become larger after the World War. Skewness in some cases moves from +

to −, while in other cases it moves in the opposite direc tion.

I shall study this question by taking individual commodities. In the case of the following articles skewness moved from + before the War to − after the War: rice, raw silk, *habutaye* silk, steel and copper. In the case of the following articles skewness moved in the opposite direction: wheat, sugar, salt, *sake*, cigarettes, coal, timber and paper. As to deviation, it has increased except in a few cases. The deviation of sugar has decreased from 0.1047 before the War to 0.0688 after the War, that of cigarettes from 0.0999 to 0.0880, and that of salt from 0.1985 to 0.1084. Those of all other coomodities have increased and the following articles show great increases: paper (0.0041 before

Table

The Dispersions and Skewnesses of General and Classified

Commodity	Maximum	Upper decile	Upper quartile	Median
Cereals	282.61	177.24	128.07	86.22
Food stuffs	222.47	177.85	121.87	92.41
Fine textiles	310.20	171.85	148.11	84.10
Metals	288.33	205.05	131.09	79.55
Fuels	289.63	331.73	151.49	81.68
Building materials	302.97	216.15	137.68	80.43
Dye stuffs and papers	328.43	228.14	163.92	74.97
Fertilizers	294.80	164.51	126.69	90.70
Miscellaneous	291.13	203.58	132.49	81.51
General averages	279.52	179.77	142.91	85.21

9) The following individual commodities are included under the classes given above: **cereals**: rice, barley, rye, wheat, soya beans, *azuki*, wheat flour; **food stuffs**: sugar, tea, salt, *miso*, soy, *sake*, dried bonito, eggs, tobacco, cigarettes, oil; **fine textiles**: raw silk, *habutaye* silk, silk-handkerchiefs, *kaiki* silk, silk for lining, floss silk, cotton yarn, imitation nankeens, cotton shirtings, cotton, ramie and china grass, flannel, mousseline, Italian cloth;

the War, 0.1790 after the War), timber (0.0338 before the War, 0.2125 after the War), steel (0.0187 before the War, 0.1520 after the War).

So far I have dealt with 14 basic commodities. I shall now take the general averages of 56 commodities and measure the dispersions and asymmetries of the following:[9] the cereals, food stuffs, fine textiles, metals, fuels, building materials, dye stuffs and papers, fertilizers and miscellaneous. Just as I calculated the general index numbers from the geometric averages of 56 commodities, I calculated the classified index numbers by means of the geometric averages of the same commodities.

The Table 6 showing the general averages and the index numbers of classes of commodities follows:

6.

Index Numbers (From October, 1900 to July, 1923)

Lower quartile	Lower decile	Minimum	Quartile deviation	Skewness from quartiles	Logarithm	
					Quartile deviation	Skewness from quartiles
79.72	72.20	55.00	24.18	+0.731	**0.1029**	**+0.669**
83.09	63.88	58.45	19.39	+0.519	**0.0832**	**+0.445**
78.50	71.78	67.63	34.81	+0.839	**0.1379**	**+0.783**
71.58	67.19	65.44	29.76	+0.732	**0.1314**	**+0.651**
72.39	61.59	56.68	39.55	+0.765	**0.1603**	**+0.673**
74.60	70.62	66.73	31.54	+0.815	**0.1331**	**+0.754**
68.08	61.40	59.01	47.92	+0.856	**0.1908**	**+0.781**
78.52	72.97	65.33	24.09	+0.494	**0.1039**	**+0.397**
76.89	68.91	63.76	27.80	+0.834	**0.1181**	**+0.786**
79.33	68.73	64.10	31.79	+0.815	**0.1278**	**+0.757**

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metals: steel, bars and rods, nails, copper; **fuels**: coal, kerosene oil, charcoal, fuel wood; **building materials**: timber, stone, bricks, piles for roofing, Portland cement; **dye stuffs and papers**: indigo, glass plates, *kami* (Japanese paper), paper, leather; **fertilizers**: rice bran, fish fertilizer, oil-cake; **miscellaneous**: mattings, lacquer, vegetable wax, matches.

In deviation the dye stuffs and paper come first, followed by fuels, fine textiles, building materials and metals (all of which are above the general averages) and then comes the following in the order given: miscellaneous, fertilizers, cereals and food stuffs. In skewness, miscel-

Table

Dispersions and Skewnesses of General and Classified

Commodity	Maximum	Upper decile	Upper quartile	Median
Cereals	115.65	103.76	88.83	82.72
Food stuffs	100.01	95.60	93.14	86.48
Fine textiles	95.11	87.01	84.18	81.93
Metals	95.82	82.65	78.68	73.77
Fuels	92.37	86.12	81.50	75.74
Building materials	98.08	90.03	80.83	78.83
Dye stuffs and papers	79.95	78.32	72.43	69.79
Fertilizers	101.52	94.91	92.66	87.70
Miscellaneous	90.57	86.26	81.00	77.69
General averages	90.27	87.67	85.29	80.04

Table

Dispersions and Skewnesses of General and Classified

Commodity	Maximum	Upper decile	Upper quartile	Median
Cereals	282.62	230.42	177.79	143.01
Food stuffs	222.47	196.10	179.06	152.11
Fine textiles	310.20	208.68	172.76	158.41
Metals	288.33	243.11	205.99	169.07
Fuels	289.63	248.18	232.18	198.82
Building materials	302.97	245.09	217.85	151.13
Dye stuffs and papers	328.43	276.96	228.15	174.28
Fertilizers	294.80	198.75	164.82	145.02
Miscellaneous	291.13	231.74	204.37	165.46
General averages	279.52	212.16	179.96	165.59

laneous leads the list, then come fine textiles, dye stuffs and papers (all of which are above the general averages), followed by building material, fuels, cereals, metals, food stuffs and fertilizers (in the order given).

As the Tables 7 and 8 are based on the price quota-

7.

Index Numbers (From October, 1900 to July, 1914)

Lower quartile	Lower decile	Minimum	Quartile deviation	Skewness from quartiles	Logarithm	
					Quartile deviation	Skewness from quartiles
76.62	61.49	55.00	7.11	+0.001	**0.0321**	**−0.036**
66.89	62.36	58.45	13.13	−0.493	**0.0719**	**−0.551**
74.35	70.69	67.63	4.92	−0.542	**0.0270**	**−0.563**
68.05	66.40	65.44	5.32	−0.076	**0.0315**	**−0.113**
63.12	60.78	56.68	9.19	−0.373	**0.0555**	**−0.426**
72.20	69.34	66.73	4.32	−0.537	**0.0245**	**−0.556**
61.94	60.83	59.01	5.25	−0.497	**0.0340**	**−0.527**
76.46	70.80	65.33	8.10	−0.388	**0.0417**	**−0.427**
71.66	65.94	63.76	4.67	−0.291	**0.0266**	**−0.320**
70.97	66.98	64.10	7.16	−0.267	**0.0399**	**−0.308**

8.

Index Numbers (From July, 1914 to July, 1923)

Lower quartile	Lower decile	Minimum	Quartile deviation	Skewness from quartiles	Logarithm	
					Quartile deviation	Skewness from quartiles
94.62	79.22	72.58	41.59	−0.164	**0.1370**	**−0.310**
100.00	88.38	86.01	39.53	−0.331	**0.1265**	**−0.451**
106.32	76.13	70.57	33.22	−0.568	**0.1054**	**−0.643**
122.29	107.96	75.61	41.85	−0.118	**0.1132**	**−0.242**
107.48	82.98	80.11	62.35	−0.465	**0.1672**	**−0.597**
92.58	74.10	73.18	62.64	+0.065	**0.1858**	**−0.145**
154.65	109.31	89.06	36.75	+0.466	**0.0844**	**+0.386**
87.41	74.76	65.42	38.71	+0.488	**0.1377**	**−0.596**
112.57	81.76	78.37	45.90	+0.152	**0.1295**	**−0.292**
109.56	83.79	79.33	35.20	+0.592	**0.1078**	**−0.665**

tions of the pre-War period and the post-War period, a comparative study of the two Tables reveal interesting points.

In skewness, cereals lead the list in the pre-War period, followed by metals, (general average), miscellaneous, fuels, fertilizers, dye stuffs and papers, food stuffs, building materials and fine textiles; in the post-War period the dye stuffs and papers come first, followed by building materials, metals, miscellaneous, cereals, food stuffs, fertilizers, fuels and fine textiles (general averages). Those which moved from + to − are cereals, fine textiles, metals, fuels and fertilizers (general averages); and cereals and the general averages are the extremes. Those which moved from − to + are food stuffs, building materials, fine textiles, and miscellaneous, the extremes being fine textiles and building materials.

We shall then study the deviation of those classes of commodities. During the pre-War period food stuffs lead the list, followed by fuels, fertilizers, (general averages), dye stuffs and papers, cereals, metals, fine textiles, miscellaneous and building materials. During the post-War period building materials lead the list, followed by fuels, fertilizers, cereals, miscellanous, food stuffs, metals, (general averages), fine textiles, dye stuffs and papers. All of the deviations of individual index numbers have increased, though in varied degrees, as the following shows: building materials (from 0.0245 to 0.1858), miscellaneous (from 0.0266 to 0.1295) and cereals (from 0.0321 to 0.1370).

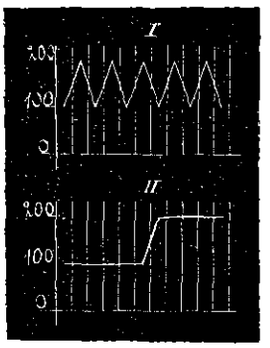
5.

A study of dispersions and asymmetries is the first step in the analysis of an index number. But such a study excludes the element of time order, its main purpose being to deal with different types. The second step is to study the range of variations.

I shall take as an example two index numbers: I and II. They have maximum of 200 and 5 numbers, while their

minimum is 100 and 6 numbers. In this respect there is no difference between the two. However, much difference exists as to their variations. Just as two countries having the same area can have different coast lines, two index numbers having the same absolute numbers can have different variations. The latter changes ten times. It increases by 100% five times and decreases by 50% five times. The former only changes but once when it increases by 100%. The one has a high degree of susceptibility to variation, while the other has a very low degree of the same quality. Thus, index numbers having the same dispersions, skewness and other qualities referred to in the foregoing tables, can be different with regards to the intensity of susceptibility to change.

Fig. 3



There are various methods by which the range of variations can be measured. I have decided to study the rates of variations by taking three different cases, namely, rise, fall and standstill. I shall study how many times within a given period do prices change (either rise or fall) and stay still. I shall then measure the range of rise and fall of prices. Not content with the time of price rises, I shall show what ratio the rate of the rise of one month bears to that of the preceeding month. The maximum and minimum of the ratio and its arithmetic average, I have named the range of rise and fall. My third step is to study the average range of variations. The number of months in a given period is taken as the divisor and the total of the absolute numbers of the ratios of rises in prices is divided, thus deriving the averages in question. The time at which prices are at a standstill is also included in the divisor, because the rate of price rise per month should be found out.

Table 9.

The Range of Price Variations of Commodities (From October, 1900 to July, 1914)

Commodity	Frequency of Variation			Range of Rise (%)			Range of Fall (%)			Average Range of Variation (%)
	Rise	Fall	Stand-still	Maximum	Arithmetic average	Minimum	Maximum	Arithmetic average	Minimum	
Rice	83	63	19	116	34.3	5	138	38.4	8	**31.9**
Wheat	81	65	19	159	39.2	6	113	43.0	7	**36.2**
Sugar	80	61	24	144	31.0	4	108	25.9	5	**24.6**
Salt	31	46	88	1,100	112.2	11	221	45.6	4	**33.8**
Sake	56	70	39	133	32.4	8	76	22.1	7	**20.4**
Cigarettes	17	19	129	221	43.5	6	25	10.5	7	**5.7**
Raw silk	78	74	13	136	31.1	7	155	27.8	8	**27.2**
Habutaye silk	65	65	35	95	24.3	10	80	25.7	9	**19.7**
Cotton yarn	72	73	20	108	30.7	6	99	25.6	6	**24.7**
Steel	43	74	48	70	31.4	10	71	22.6	2	**18.3**
Copper	62	66	37	118	30.5	7	110	28.9	9	**23.0**
Coal	52	59	54	165	27.8	8	71	17.5	7	**15.0**
Timber	31	38	96	105	41.6	9	104	31.2	9	**15.0**
Paper	11	7	147	37	18.3	9	36	18.6	9	**20.0**

Table 10.

The Range of Price Variations of Commodities (From July, 1914 to July, 1923)

Commodity	Frequency of Variation			Range of Rise (‰)			Range of Fall (‰)			Average Range of Variation (‰)
	Rise	Fall	Stand-still	Maximum	Arithmetic average	Minimum	Maximum	Arithmetic average	Minimum	
Rice	58	45	5	275	57.6	4	180	51.5	2	**52.4**
Wheat	57	46	5	280	69.9	7	235	68.5	3	**66.1**
Sugar	53	51	4	360	58.4	3	214	44.3	3	**47.6**
Salt	8	4	96	284	94.8	10	95	50.0	3	**8.9**
Sake	42	37	29	424	102.9	5	279	80.2	7	**67.5**
Cigarettes	2	—	106	288	226.5	165	—	—	—	**4.2**
Raw Silk	55	40	13	229	70.6	7	312	69.3	6	**61.8**
Habutaye silk	62	38	8	220	51.8	6	238	57.2	6	**49.9**
Cotton yarn	61	45	2	406	72.6	3	304	74.8	2	**72.2**
Steel	49	56	3	547	107.2	2	257	69.1	4	**84.8**
Copper	56	42	10	167	39.2	6	187	40.1	6	**35.9**
Coal	51	26	31	260	29.0	2	66	24.7	7	**19.7**
Timber	36	29	43	240	60.6	9	114	35.9	10	**29.8**
Paper	26	28	54	471	97.8	6	133	53.9	6	**37.5**

I have selected 14 basic commodities out of the 56 commodities selected for the index numbers of the Bank of Japan and made the Table 9 containing frequency of variations, range of rise and fall and the average range of variations.

In order to make a comparative study of the variations of prices during the period before the World War and those of the post-War period up to the great earthquake of 1923, I made Figure 10 which is as follows.

A comparative study of the Tables 9 and 10 reveals the fact that the variation of prices after the World War is greater than that of the pre-War days. I shall now make a comparative study of the number of variations, the range of rise and fall of prices and the average range of variations, of the two periods.

The average range of the variation of the price of each commodity is greatly increased during and after the War. This is an indication that the prices of commodities were greatly affected by the World War. The extreme cases are steel (18.3% before the War and 84.8% after the War) and paper (2.0% before the War and 37.5% after the War). The exceptions are cigarettes and salt. During the pre-War period including the years of the Russo-Japanese War, the percentage of salt was 5.7% and that of salt was 33.8%. After 1914 the percentage of the former decreased to 4.2% and that of the latter to 8.9%.

Great increases were also registered in the case of the range of rise and fall in prices during and after the World War, which affected prices very materially, those of salt being the only exception.

I shall next consider the number of variations in prices. The same tendency is also seen here. Excepting salt, *sake*, cigarettes and raw silk, the frequency of rise and fall in prices is greater, and that of standstill is much less during and after the War. The extreme case is to be found in steel, whose number of standstill in prices before the War was $\frac{48}{165}$ which came down to $\frac{3}{165}$ after the War. On the

Table 11.

TheR ange of Price Variations of Commodities (From October, 1900 to July, 1923)

Commodity	Frequency of Variation			Range of Rise (‰)			Range of Fall (‰)			Average Range of Variation (‰)
	Rise	Fall	Stand-still	Maximum	Arithmetic average	Minimum	Maximum	Arithmetic average	Minimum	
Rice	141	108	24	275	43.9	4	180	43.9	2	**40.0**
Wheat	138	12	24	280	51.9	6	235	53.6	3	**48.0**
Sugar	133	112	28	360	41.9	3	214	34.3	3	**34.5**
Salt	39	50	184	1,100	108.6	10	221	46.0	3	**23.9**
Sake	98	107	68	424	62.6	5	279	42.2	7	**39.0**
Cigarettes	19	19	235	288	62.7	6	25	10.5	7	**5.1**
Raw silk	133	114	26	229	47.4	7	312	42.5	6	**40.9**
Habutaye silk	127	103	43	220	37.7	6	238	37.3	6	**31.6**
Cotton yarn	133	118	22	406	49.9	3	304	44.4	2	**43.5**
Steel	92	130	51	547	71.8	2	257	42.6	4	**44.5**
Copper	118	108	47	167	34.7	6	187	33.2	6	**28.1**
Coal	103	85	85	260	28.4	2	71	19.7	7	**16.9**
Timber	67	67	139	240	51.8	9	114	33.2	9	**20.9**
Paper	37	35	201	471	74.2	6	133	46.8	6	**16.1**

contrary, that of salt before the War was $\frac{88}{165}$ and afterwards $\frac{96}{108}$. That of cigarettes before the War was $\frac{129}{165}$ and after the War, $\frac{106}{108}$.

The Table 11 shows the variations of prices during the period extending over 23 years.

Rice leads the list of the numbers of rises in prices, followed by: wheat, sugar, raw silk, cotton yarn, *habutaye* silk, copper, coal, *sake*, steel, timber, salt, paper and cigarettes (in the order given). In the case of price fall, steel leads the list, followed by: cotton yarn, raw silk, sugar, wheat, rice, copper, *sake*, *habutaye* silk, coal, timber, salt, paper and cigarettes (in the order given). In the case of standstill, cigarettes lead the list, followed by: paper, salt, timber, coal, *sake*, steel, copper, *habutaye* silk, sugar, raw silk, rice, wheat and cotton yarn (in the order given). It should be noted that cigarettes, paper and salt have the smallest number in both rise and fall of prices, yet occupying the first place in regard to the number of standstill.

In studying the range of rise and fall in prices, we must treat each case separately. In the arithmetic average of rise in prices, salt comes first, followed by: paper, steel, cigarettes, *sake*, wheat, timber, cotton yarn, raw silk, rice, sugar, *habutaye* silk, copper and coal (in the order given). In the arithmetic average of fall in prices, wheat leads the list, followed by: paper, salt, cotton yarn, rice, steel, raw silk, *sake*, *habutaye* silk, sugar, copper, timber, coal and cigarettes. Nearly all commodities show about the same numbers in both rise and fall in prices. Rice, for instance, is 43.9% in both rise and fall. Here also cigarettes and salt are exceptions, their arithmetic averages of rise in prices being twice and six times respectively of their similar averages in fall.

In the average range of variation in prices, that of wheat is the greatest, followed by: steel, cotton yarn, raw silk, rice, *sake*, sugar, *habutaye* silk, copper, salt, timber, coal, paper and cigarettes. Here again salt, cigarettes and paper occupy a special position.

It has been seen, that some commodities have a high degree of fluctuability in their prices, while others have a very low degree of the same quality. Rice, for instance, has a very high degree of fluctuability, while cigarettes, the representative of government monopoly, is an example of the opposite tendency. In the last 273 months the price of rice rose 141 times, fell 108 times and remained stationary 24 times; whereas that of cigarette rose and fell 19 times and remained stationary 235 times.

In the average range of variation, that of the price of rice is 40.0% and that of cigarette is 5.1%. These are two extreme cases. It may be added that all commodities have different degrees of fluctuability.

There are several points which should be noted in this connection, and they all arise from the fact that the index numbers of the Bank of Japan are based upon the average prices of each month and that each of the prices is calculated on the basis of the price of October, 1900, which is taken as 100. As each price is the average price of each month, the price of a time shorter than a month is not taken into account, and consequently does not affect an index number. Secondly, since the prices are calculated on the representative number of 100, any variation smaller than one percent of the prices does not affect the index number. In consequence, when a price is below the price of October, 1900 (80, for example), changes which are above one percent (1.25 for example) only will be able to affect the index number. On the other hand, when a prise is greater than that of October, 1900 (800, for instance), changes smaller than one percent can affect the index number. This is the main cause of the fact, that, whereas during the pre-War days when prices were low, the unmber of variations in prices was small and the range of the variations was narrow, the opposite tendencies were seen during the post-War days when prices were high.

6.

I have completed the present study of the index numbers of the Bank of Japan with special reference to the three points which I have enumerated at the outset. I have made an improvement in the old method of studying index number by changing the basing time and by replacing arithmetic averages by geometric averages in synthesizing the index number of individual commodities. Again, I have explored a new field in the study of index numbers by investigating the dispersions and skewnesses of index numbers and the range of variations in prices.

One of the defects in the old method of studying index numbers has been the neglect in investigating into the minute organization of an index number, chiefly because of an overeagerness to find its universality and common characteristics. The basing time was fixed such as the one adopted by the Bank of Japan, while the types of index numbers have been limited to an arithmetic average or maximum and minimum. But an excessive universalization often results in overlooking important characteristics of component elements. Keeping such a danger in my mind, I sought the basing time in the whole period, thereby establishing a close relation between the whole and the parts; I have also made use of dispersion and skewness in order to clarify the matter, especially with regard to the average. I measured the range of variation in prices in order to understand the fluctuability or non-fluctuability of commodities. The universality of an index number can only be understood by studying its peculiarity. Thus, various basing times, dispersion, skewness, fluctuability or non-fluctuability of prices—these are the chief topics of study.

In short, I have paid special care in the selection of methods of study, along with facts involved. I confess that I have left untouched such things as the following: basic commodities, basic brands, weighting, the dispersions and skewnesses of the monthly numbers of 56 individual com-

modities. I also failed to go beyond the quartile deviation and the skewness from quartiles in studying different types of index numbers. Neither did I go into the classified and general index numbers in studying the range of price variations. However, I did my utmost in dealing with the topics which I have so far studied.

I wish to add, that the present study was possible because of 18,018 cards which were prepared by my one and only assistant and because of the Brunsviga calculation machine; especially to my assistant I can not be too much thankful. These cards are preserved at the Department of Economics of the Kyoto Imperial University for the use of future investigators.

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