Industrial Development in Republican China,
Newly Revised Index: 1912-1948

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Introduction

It is necessary for us to make proper index series of the production, when we would like to understand the long term economic trend in each of countries or areas. As I have written preliminary reports on Chinese modern industrial output series in the first half of the 20th century (Kubo [2001], Kubo [2005b]), today I will show you a newly revised one. The PRC Government tends to emphasize their economic achievement after 1949 and underestimate the economic development before 1949 even now. Their interpretation should be corrected, because we could not really understand the East Asian economic growth in the long-run perspective without such correction.

Recently we often hear so-called the miracle of economic development in East Asia. In fact Japan has passed highly economic growth from the 1950s to the 1970s. Hong Kong and Taiwan followed similar experience from the 1960s to the 1980s. And now, especially since 1990s until now, Mainland China's economy is developing at high rates. Naturally most of the studies concentrated on the economic history in the latter half of the 20th century. In addition, however, we should pay attention to the first half of the 20th century, because there seem to be some kind of continuity in the East Asian economic development during the whole of the 20th century.

This paper will deal with Chinese industrial development in the first half of the 20th century. The most representative work related to this research was John K. Chang's book (Chang [1969]). Chang's compilation of 1912-1949 industrial production index based on the output series of 15 mining and industry products was unquestionably a significant achievement. But, at the same time, we could not help to consider several problems in his work as showed in the following discussion.

After the brief introduction and reconsidering about Chang’s index, at first, this paper takes up the cotton textile sector, which had a 20% share in modern Chinese industry and makes new estimates for cotton yarn production. Secondly this research attempts to make estimates of the output of the silk industry which stood second in Chinese modern textile industry. Filature silk was one of the very important exports for China during the first half of the 20th century. Nevertheless we could
not find any statistics or proper estimates about the output series of Chinese filature silk. The third purpose of this research is put on the trial to calculate flour output produced by machinery. We had almost no information regarding the output of Chinese food industry during this period, while it occupied a very significant position in Chinese industrial development. At last, we also try to improve a part of the Chang’s index in several output series of the other products.

1. The Data of John K. Chang’s Index

John K. Chang used the output data series of the 15 products including coal, iron ore, iron, steel, antinomies, copper, gold, mercury, tin, tungsten, cotton yarn, cotton cloth, cement, crude oil and electric power to make his index. He properly pointed out that before and after the 1930s, industrial statistics were not compiled systematically for the nation as a whole either by governmental or by private agencies (Chang [1969] p14). But the series of mineral and metallurgical products are not only more complete but also reliable than the others. So he selected the ten products. On the contrary, the five remaining series including cotton yarn, cotton cloth, cement, crude oil and electric power are of inferior quality as compared to the above ten. Using various estimating methods, Chang provided output estimates.

In fact, the Chang’s index included very few items that belonged to the modern industry (only limited to cotton yarn, cotton cloth, iron, steel and cement by the classification standard of the United Nations). As Chang himself also recognized that types of products were small and biased towards mining sector, he evaluated the effects of these problems by referring to developments in other sectors. According to his assessment, his index, which had only about 40% coverage in net value-added factory production, does not overestimate the actual rate of industrial production up to 1920; for the 1920s and the subsequent years through to 1936, there would seem to be no significant biases in either direction; and after 1936, at least during the war years, the index definitely understates the actual rate of industrial growth (Chang [1969, p57]).

In spite of Chang’s explanation, we can not deny the fact that the output series fall far short in the consumer goods industries including the food and beverage industries and part of the textile industries. In addition, we can revise or make new estimates in the output series of the consumer goods industries by using new materials published after his study.

2. New Estimates on Cotton Yarn Production, 1912-1936

Cotton spinning industry was the largest mechanized industry in the Chinese modern economy
during this period. It should be noted that there seemed to be many factors contributing to the
development of Chinese cotton industry including Chinese investment and innovation of
management by themselves as same as Japanese investment and technology transfer in China (Kubo
[2005a]). Anyway it is very important to make an estimate of cotton yarn production exactly,
because the output of the cotton spinning industry dominated the whole of the industrial output in
China during the first half of the 20th century.

We have several kinds of statistics and estimates on the modern Chinese cotton yarn
production. The statistics compiled by Wang Zijian and other specialists (Shanghai shi Mianfangzhi
Gongye Tongyegonghui Choubeihui [1951], hereafter refereed to as *Cotton Industry Statistics*) was
the most reliable one among them, while it also needs some revisions. John K. Chang also used a
part of *Cotton Industry Statistics*, though he missed its problems. So, first of all we would like to
point out the problems and limitations of *Cotton Industry Statistics*.

*Cotton Industry Statistics* consisted of 17 series of annual statistics compiled by the
Association of Chinese Cotton Spinners in the pre-war period. It recorded annual conditions of
production, equipment, workers, raw cotton and output of every cotton mill. It is the most
comprehensive and inclusive production statistics for the cotton industry. However, besides the
problems of missing issues in a couple of years, there also existed the following problems. (1). The
period and items of the statistics were not consistent; (2). The production status was based on
self-reported information by every cotton mill, which included some incorrectness; (3). Some
cotton mills, mainly consisted of British-owned and Japanese-owned mills, did not respond to the
requests for reporting; (4). Quite a large number of mills engaging in both spinning and weaving
operations did not report all of their cotton yarn output. The last problem is a difficult one to solve.
Hereafter we call it the combined mill’s problem.

Considering the above mentioned problems and limitations of *Cotton Industry Statistics*, several
scholars have tried to make their own estimates regarding the output of Chinese cotton industry.
Their main results and problems were as follows.

(A) Wu, Baosan [1947] (hereafter referred as Wu’s estimate)

Although Wu made efforts to obtain accurate output by using the tax bureau statistics, he only
estimated the output of 1933 because of his purpose to calculate Chinese national income in 1933.
In addition, while he pointed out the important problem of cotton yarn output used for own
production in factories with both spinning and weaving operations, he still used the tax bureau
statistics without any revision, which failed to capture this production.

(B) Yan, Zhongping [1955a, p363 (table 12)] (hereafter referred to as Yan’s estimate)

Yan’s estimate used the data of raw cotton consumption in *Cotton Industry Statistics*. It
estimated cotton yarn output by assuming a 10% raw cotton loss in spinning cotton yarn. In other
words, according to Yan’s estimate, raw cotton consumption multiplied by 0.9 becomes cotton yarn
output. This method enabled to include the yarn output by the combined mill. Unfortunately, however, as the reliable cotton consumption data were only limited to the period 1931-1936, long-term output series could not be obtained by this method.

(C) Chao, Kang [1977] (hereafter referred to as Chao’s estimate)

For the period of 1890-1919 not covered by Cotton Industry Statistics, Chao made estimates by capital productivity. He used 250 pounds per spindle, which means about 0.625 bales per spindle, as the annual yarn output. So total number of spindles multiplied by 0.625 becomes cotton yarn output in bales. For 1920-1936, Chao’s estimate used Cotton Industry Statistics with some revisions including an important trial to solve the combined mill’s problem. Chao’s estimate was consistent in methodology and covered the long period from 1890, the beginning of modern cotton textile industry to 1936.

But we have to point out the revisions by Chao did not succeed. At first, Chao’s revision regarding the combined mill’s problem was limited to only 1 or 2 mills, while there were many combined mills that did not report all of their yarn output (see Takamura’s estimate). Secondly Chao estimated cotton yarn output by assuming a 17% raw cotton loss in spinning cotton yarn. This was too high compared with the 10% cotton loss estimate used by Yan. Thirdly, Chao’s estimate did not pay proper attention to the time lag in Cotton Industry Statistics between productive equipment and output.

(D) Takamura, Naosuke [1982] (hereafter referred as Takamura’s Estimate)

Takamura’s estimate solved the combined mill’s problem. He started from choosing those mills which were necessary to revise their output data. In case of unusual high rate loss of raw cotton in some combined mills’ production data, Takamura made the judgement that these mills did not include all of their yarn production in their yarn output reported. Regarding such mills, he estimated their yarn output for their own weaving by using their cloth output data in Cotton Industry Statistics. Takamura assumed 40 square yards of cloth required 11 pounds of yarn, which means 0.02169 bales of yarn (1 bale = 420 pounds). Then he added this estimate with the yarn output data reported in Cotton Industry Statistics (see Takamura [1982, Table 6 in p.98, Table 17 in p.169).

This revision gives the best estimates of the real cotton yarn production including the output in the combined mills. However, the revision was limited to Japanese mills in China only and also limited to the period from 1927 to 1936.

(E) Ding, Changxian [1987] (hereafter referred to as Ding’s estimate)

Using the data of spindles in the statistical materials (Yan [1955a]) for 1913 and Cotton Industry Statistics for 1921, 1931 and 1936, Ding made estimates by capital productivity. Because Ding’s estimate could include all of the yarn output in combined mills, it revised upward the output data in Cotton Industry Statistics. Ding’s estimate is appeared in an authoritative book published in the late 1990s (Zhongguo Jindai Fangzhish Bianweihui [1997]).
But the value of Ding’s estimate was diminished as it was limited to only 4 years, not a time series data. Moreover, the figure for the yarn output per spindle are doubtful. The figure Ding used was as follows: 0.6248 bales for 1913, 0.6299 for 1921, 0.6344 for 1931 and 0.668 for 1936. It is likely that productivity could rise somewhat. However, average yarn output by spindle as measured by weight should decline as the quality upgrading of cotton yarn proceeded during this period.

In sum, although *Cotton Industry Statistics* has great value for making the output series of cotton yarn production in modern China, we need to revise it to make proper estimates and there was no good complete estimate in the past.

Then, how shall we approach to compile the time series statistics of cotton yarn output? As I have already written this problem in my paper (Kubo [2001]), here I would like to discuss briefly.

1). For the period before 1919, we use the method of capital productivity. We use the annual spindle data of Ding’s estimate and use the methodology of Chao’s estimate. Originally, we should take into account the change of the capital productivity and the operated days in each mill. Unfortunately we do not have enough data to make such adjustments.

2) For the period of 1920-1936, we basically use *Cotton Industry Statistics*, making references to Chao’s estimate and Takamura’s estimate. Especially, Takamura’s method to solve the combined mill’s problem enables us to make a significant upward revision of the data in *Cotton Industry Statistics*.

Needless to say, we should utilize all the information. Besides *Cotton Industry Statistics* and the above mentioned estimates, we also use enterprise level information (such as Shenxin, Yong’an, Fuyi, Xinyu, Qingdao Huaxin, Yuci Jinhua, Yuhua, Dahua, Daxing and other cotton mills) to try to improve the output series. Also for the Northeast China, we use the reliable factory statistics compiled by the Japanese in the 1930s.

The result of our estimates is showed in Figure 1.

J. K. Chang used the output series of the cotton industry in the Northeast China as the basic data to calculate the nationwide output series of Chinese cotton industry during the Sino-Japanese war period. But it should be correct because the cotton industry in the Northeast China could not represent all of the Chinese cotton industry. In fact the cotton industry in Shanghai where half of the Chinese cotton mills located experienced a big boom from 1938 to 1941, while the output of the cotton industry in the Northeast China declined very much because of raw cotton deficiency. Using enough raw cotton bought from the international market, Shanghai cotton mills could make a lot of cotton yarn and textile during the first half of the war times. So due to using the output data of cotton yarns in the Northeast China, J. K. Chang underestimated the nationwide output of Chinese cotton industry from 1938 to 1941.

Then how can we get adequate data of the nationwide output series of Chinese cotton industry during the war period? We can find the output statistics in the Northeast China and the Free China (the Southwest China). At the same time, in this study, we use the average output per spindle estimation (capital productivity series) to calculate the output in the Central China and the north China. As there were big differences among each of the capital productivity of cotton mills, we use several kinds of capital productivity data classified by the capital nationalities and the mill's location. Especially regarding the productivity of Chinese cotton mills in Shanghai, our estimate is based on the management materials of several famous cotton mills including Shenxin no.9, Yong’an no.3 and Xinyu.
As a result, our new estimate on the nationwide output series of Chinese cotton industry from 1938 to 1941 becomes much higher than J. K. Chang's estimate (See Figure 1). This trend is similar to the other estimate in the journal published just after the war.

4 . Silk Industry and Silk Weaving Industry, 1912-1948

Partly mechanized silk industry in China started at Shanghai in 1861, though it once abandoned a few years later because of many difficulties (Ishii [1998]). But as the reputation of Chinese handicraft silk declined in the world market, several merchants tried to introduce the new equipment to produce filature silk to export. After the 1870s in Guangdong province and the 1880s in Lower Yangzi basin, many Chinese merchants established lots of factories producing filature silk to export the world market (Suzuki [1992]). The number of factories in 1930 was as follows.

| Table 1  Number of Silk-reeling Factories |
|---------|------------------|------------------|------------------|------------------|
|         | Shanghai         | Lower Yangzi Basin* | Guangdong | Sichuan |
| Number  | 107              | 81                  | 121         | 20      |

Note: * Excluding Shanghai.

Silk weaving industry using electric power also began at Shanghai in 1915 and after the 1920s the output increased very fast by using rayon (artificial silk) with natural silk. As silk industry and silk weaving industry had about a 8 percentage of total industrial production and occupied the second important position in Chinese modern textile industry, we should pay an attention to their output to compile an adequate industrial output index series. But we do not have the statistics of output of silk or silk weaving. So we try to make an estimate.

It is not easy to make an estimate on the output series of filature silk by using the capital productivity data. Because we do not have annual number and productivity data of silk reeling machine, while we have a rough estimate of number of silk reeling factories in the specific years. So in this study, we mainly use the export trade statistics to calculate the output of filature silk because most of filature silk were exported in that times. Of course as a part of filature silk consumed in the silk weaving mills in China were not exported to abroad, the total of export and domestic consumption indicated the output of filature silk. Xu Xinwu’s book made an estimate by using the
assumption that a 90% of filature silk was exported to abroad in every year (Xu [1990, p661]). However this method is too rough because the ratio of exports changed in every year due to the various factors, including the influence of the world market and the domestic demand. We can not depend on Xu Xinwu’s estimate.

At first we can use the method of estimation by capital productivity series to compile the output of silk weaving industry and their annual consumption of filature silk. On one hand, we refer Xu Xinwu’s book to get number of machines. In this book Xu and his colleagues collected various data about number of silk weaving machines by electronic power in the main places of production (Xu [1991, pp.130-252]). Though their data was imperfect and limited within Lower Yangzi Basin, it could represent the total trend in China. According to Liu Dajun’s investigation, the ratio of the production in other districts occupied only 1.7% of Lower Yangzi Basin in 1933 (Liu [1937]). So using Xu Xinwu’s data, we could make an annual estimate of number of silk weaving machines by electronic power in China from 1915 to 1949. On the other hand, using the data of the Meiya silk weaving mill (Zhongguo Jindai Fangzhish Bianweihui [1997, vol.2, p.443]), which was one of the biggest silk weaving mills in China, we can get annual productivity data per a silk weaving machine. So total number of weaving machines multiplied by Meiya’s productivity data becomes silk goods output series. Our estimate uses these figures, excluding the data of the war time Shanghai where very exact statistics on the production of silk weaving industry was compiled from 1937 to 1944 (Xu [1991] p.176, 215, 217).

Secondly we must make an estimate of the filature silk consumption in silk weaving industry. It is a little complicated task because the silk weaving industry in that period used not only filature silk but also artificial silk or fine cotton thread as their principal materials. On one hand, according to many sources, we know the fact that Chinese silk weaving industry started use Artificial silk after the middle of the 1920s. On the other hand, Liu Dajun’s investigation gives us the useful information about the raw materials of the silk weaving industry in 1933. Using such data, we made an annual estimate on the ratio of the materials and calculated the annual consumption of the filature silk in the silk weaving industry.

At last we can get the output series of silk industry by adding the export data and the domestic consumption data (See Figure 2). How could we evaluate our own estimate? A Japanese researcher Uehara Shigemi proceeded special research activity on Chinese silk industry during the 1920s and wrote a thick report (Uehara [1929]). He made a detailed estimate on the output of Chinese silk industry in 1926, though his estimation was limited only that year. Fortunately, our estimate in 1926, 118,422 Haiguan piculs is basically coincided with Uehara’s estimation, 126,450 Haiguan piculs. By other sources, the ratio of domestic consumption of filature silk was considered about a 10% during the 1920s (Xu [1990] p.661) and about from 20% to 30% during the 1930s (Liu [1937] vol.2 p.639, p.559, Koa-in [1942]p.322-323). Our estimate also shows the similar trend.

The out series of silk industry and silk weaving industry are striking by their sharp decline after
the 1930s. The World Depression happened in 1929 damaged the silk industry very hard, as silk goods are luxurious things. Compared with the price of cotton yarn, the price of filature silk showed very sharp decline (Kubo [1995] p.23). In the 1930s, the silk weaving industry tried to develop by cost down, using cheaper materials like as artificial silk. But Japanese invasion and the WWII hit the both of the industries.

In combining the individual output series, we must decide a weighting system. After examining the various methods, John K. Chang used Wu's price data in 1933 (Chang [1969] p.31-32). As our estimate originally aimed to revise Chang’s index, we use the same data provided by Wu and his colleagues to combine our estimation on the output series of silk industry and silk weaving industry. It means that the average price of filature silk is 520.3 yuan per 50kg and the average price of silk goods is 27.088 yuan per 40 yards (Wu [1947] vol.2, p.101, 104).

5. Flour-Milling Industry

In spite of the importance of the food industry in Chinese modern industry, we could not find its adequate output series to use to make the industrial index during the first half of the 20th century. That was the main reason why John K. Chang did not use the output series of the food industry when he made his index. But fortunately, now we can use new two books on the flour-milling industry that Chang could not refer in his work. One is a statistical book classified as “neibu faxing [inner publishing]”, that means common researchers could not use it in those days (Zhongguo Kexueyuan Jingji Yanjusuo he Zhongyang Gongshang Xingzheng Guanliju Zibenzhuyi Jingji Gaizao Yanjiushi.
bian [1966], hereafter refereed to as *Flour-Milling Statistical Materials*. Another is a research book summarizing many research books and materials published in China during the 1960s and the 1970s (Shanghaishi Liangshiju, Shanghaishi Gongshang Xingzheng Guanliju and Shanghai Shehuikexueyuan Jingji Yanjiusuo Jingjishi Yanjiushi bian [1987], hereafter refereed to as *Flour-Milling Industry*). Using their data, we will try to make an estimate on the output series of the modern Chinese flour-milling industry.

Modern flour mills were first established in the wheat-producing areas in such large cities as Shanghai, Wuxi, Tianjin, and Harbin. The research books show us the annual number of mills including the data about their equipment and the productive abilities in a day. Mills built by Chinese were listed in *Flour-Milling Statistical Materials* (p.32-35) and mills built by foreigners were listed in *Flour-Milling Industry* (p.518-527).

It is very important for estimation to get the data on the operational days in every year, because the operational situation of the flour-milling industry was strongly influenced by the domestic wheat harvest and the world grain market in every year. Sorry to say, however, there were not perfect annual data about the operational days of all of the flour mills. Using the very fragmentary data about the operation days in the several districts (*Flour-Milling Industry*, p.121, 138-139, 152-153, 160, 263), we can only make a rough estimate on the operational situation.

Anyway, as we have already gotten the two kind of data series, here we can use the method of capital productivity again. The total productive abilities of flour mills multiplied by the estimate of annual operational days becomes mechanized-mills-flour output series. We also use Wu’s price data 2.25 per 22kg to integrate it to the total industrial index (Wu [1947] vol.2 p.128).

The result shows us that the output of the flour-milling industry was very unstable and changeable compared with other industries. As lots of handicraft flour mills remains in rural area, large parts of wheat was often consumed in rural area and was not brought to the machinery flour mills in cities. Especially when the wheat crop failed or the transportation from rural area to cities stopped, the flour-milling industry in cities had to decrease the operational days. A part of big flour mills situated in Shanghai or such open ports, however, could use foreign wheat imported from the world market, if the price of wheat in the world market was enough cheap for them. Those complicated situation were main reasons why the output of flour-milling industry showed much unstableness (Kubo [1995] p.26-27).
6. Other Revisions

In addition to the revision regarding cotton, silk and flour-mills industries, we revised several estimates in the other output series as follows.

1) Output in the district under the Chongqing National Government's rule during the War period

Using several original data, we can revise a part of the output data in the district under the Chongqing National Government's rule (the Southwest China) during the War period.

2) Output in the Northeast China (Manchuria) during the War period

Using "Kojo tokei sokuho"("Prompt report of industrial statistics"), we can revise most of the output series of industrial production in the Northeast China during the War period.

3) Output of the electric power stations in the Central China during the War period

We can refer the documents of "Kachu suiden"(Central China Electric Power Co.) to revise Chang's data.

4) Output of the cement industry in the Central China during the War period
We can refer the documents of "Shanghai shuini gongsi" (Shanghai Cement Co.)
to revise Chang's data.

Conclusion

The coverage of our estimate rises about 71.6% of total output of Chinese modern industry in 1933, while the coverage of Chang’s estimate reached only 50.9%. Needless to say, compared with Chang’s index, our estimate reflects the more detailed trends of the more kinds of light industry in modern China.

Table 2  The Coverage of Industrial Output Estimates, 1933

<table>
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<tr>
<th>Covered Industries</th>
<th>Output of Covered Industries</th>
<th>Total Output*</th>
<th>Coverage</th>
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<tbody>
<tr>
<td>Kubo's Estimate</td>
<td>1,384.9</td>
<td>1,935.4</td>
<td>71.6 %</td>
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<tr>
<td>Chang's Estimate</td>
<td>986.4</td>
<td>1,935.4</td>
<td>51.0%</td>
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The result is as follows (See figure 4 and Table 3). At first, we can find the rapid growth of modern industry until 1936 in China, while the damage caused by Japanese invasion was very severe after 1937. Too high rate of Chang’s index 9.7% from 1912 to 1936 should be revised by our more moderate estimate 8.0%. Nevertheless even our new rate shows very high compared with the data of other countries or other periods in China. Regarding the difference between our index and Chang’s index during and after the War period, we will talk afterwards.

Secondly, the post WWI depression did not cause a large decline on the overall production. While Chang’s index showed a drastic drop of production in 1922, our revised figures showed only a little slowdown in the development. The Chang’s index possibly exaggerated the adverse impact of the post WWI depression on the entire Chinese modern industry.

The third point is about the assessment on the industrial production during the Sino-Japanese War. Our index showed the bottom in 1937 and the peak in 1939 from 1937 to 1944. Chang’s index, however, showed the bottom in 1938 and the peak in 1942 during the same period. The reason of this difference should be found in the bias of the commodities of Chang’s index. As Chang used only a
few imperfect data of light industry products and mainly depend on the data of mining products, his estimate missed the recovery of the industrial output after 1938 to 1940 and gave too high evaluation in 1942. According to our revised figures, we should recognize some kind of recovery from 1938 to 1941 during the War, although the industrial production sharply declined after 1942.

The last implication is about the appreciation on the economic development after 1950s. Most parts of the industrial growth in the early 1950s were the recovery to the pre-war period and were not the results of the policy pursued by the PRC.

Table 3 Comparison of Growth Rate
of Industrial Output Series

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<td>1912-49</td>
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