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Russian Industrial Growth:
An Estimation of a Production Index, 1860-1913

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Introduction*)

The purpose of this paper is to construct an index of real industrial production for the Russian Empire in the period between 1860 and 1913. The number of precedents for an estimation of this kind has not been very numerous. As far as the author knows, at most four estimates can be mentioned as main estimation efforts. Table 1 shows characteristics of these four estimates and of the author's own in this paper (for concrete figures of each index, see Table 16 below).

Of these estimates the original Kondratieff series is the first estimate and can be said to be an excellent index. Although it was made in the mid-1920s, it has many interesting features even from today's viewpoint. The Kafengauz index, which was constructed slightly later than the Kondratieff series, employs more sample products in calculating the index than the latter. Also the estimation was conducted on the basis of the territory of the Soviet Union as of the end of the 1920s. It is noteworthy that the Kafengauz series was made open to public only in 1994, nearly 70 years later than his actual calculations[1].

The Kondratieff and Kafengauz indices have a common drawback: the estimation period is rather short, namely, from 1885 (1887) to 1913. As opposed to these estimates, the Nutter series covers a much longer period, from 1860 to 1913, and employs 26 industrial products in estimating the index, exceeding the Kondratieff series in the number of sample products. Nutter's figures, however, are published every five years, for 1860, 1865, 1870 and so on. In addition, the base year[2] for weights of his calculations is only 1913, the last year of the estimation period over 53 years. As is well known, Nutter's study centers on the development of the Soviet industry, and hence it is quite understandable that he himself modestly states that "none of our discussion of industrial development in pre-Revolutionary Russia should be taken as definitive, since we have not undertaken an exhaustive study of this period." ([24, p. 343]).

At the moment, judging from the frequency of reference, the Goldsmith index can be regarded as the most authoritative estimate of real production for

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*) This paper is an English version of the author's paper [26-4]. The paper has been revised on translation.

1) The publication of his book is said to have been called off due to the repression by the Stalinist regime ([5, стр.4-5]; [4, стр.490]).

2) In this paper the "base year" is strictly distinguished from the "reference year". The former means a year when weights are taken, whereas the latter is a year when the value of an index is put as the standardised value (that is, 1 or 100).

Tsarist Russia's industry. As stated in detail later, while this series is based on the Kondratieff index, the estimation period is extended back to the year 1860 and some significant alterations in estimation methods are carried out. The number of sample products, however, is less, that is 20 items, and more importantly, this index seems to demonstrate a tendency towards underestimation regarding the growth of Russian industry.

The author's index, like the Goldsmith index, is calculated for each year from 1860 to 1913. The two, however, differ significantly in many ways. The former has more sample products, and weights for product indices and methods of averaging are different from those in the latter. In addition, the author calculates production indices not only for industry as a whole, but also for 7 industrial branches which conform to the classification rules of Soviet times. In these respects the estimation in this paper might be regarded as having a certain degree of significance.

Table 1 Estimations of industrial production index for Tsarist Russia

Index (publication year)	estimation period	territory	number of products	weight	base year	form of averaging
Kondratieff (1926)	1885 - 1913	Tsarist Russia	21	value added	1900	geometric
Kafengauz (1929 ? ,1994)	1887 - 1927	Soviet Union at the end of the 1920s	29	labour force, total output value	average for the estimation period	arithmetic
Goldsmith (1961)	1860 - 1913	Tsarist Russia	20	value added	1887, 1900, 1908	arithmetic
Nutter (1962)	1860 - 1913 (every 5 years)	Tsarist Russia	26	value added in industry	1913	arithmetic
Suhara (this paper)	1860 - 1913	Tsarist Russia	31	price, labour force	1887, 1890, 1900, 1908, 1912	arithmetic

Notes : "Territory" means the subject area to estimation. "Number of products" means the number of sample products employed in the estimation. "Form of averaging" means the form employed in averaging the product or branch indices. While Kafengauz seems not to have specified the form of averaging in his book, Gregory [4, стр.478] states that an arithmetic mean was employed in Kafengauz's estimation.

Source : For the Kondratieff, Kafengauz, Goldsmith and Nutter indices, see [7], [5, стр.287-288], [20], [24, pp.343-345], respectively. For the Suhara index, see following descriptions in this paper.

This paper is organized as follows. In Section I the Kondratieff index is examined, and the Goldsmith index is investigated in Section Ⅱ. The Kafengauz and Nutter indices are referred to when necessary. In Sections Ⅲ and Ⅳ the author's estimation is explained in detail and compared with other indices. In the last part of this paper some shortcomings of the author's estimate are mentioned and future research directions are suggested[3].

Ⅰ. The Kondratieff production index

The first example of research efforts at estimating a production index for Tsarist Russia's industry to be cited is the series generally called the Kondratieff index, made in the mid-1920s.([7, стр.12-21]). The Conjuncture Institute affiliated to Narkomfin (People's Commissariat of Finance) compiled a real production index for Russian industry from 1885 to 1913 and published it in *Economic Bulletin*, the Institute's journal. Nikolai Kondratieff served at that time as director of the Institute. In the following section I will briefly examine how the index was constructed[4].

Ⅰ-1. Data on products

The basic data of the Kondratieff index is, as Table 2 shows, the physical output for each year from 1885 to 1913 of 21 products classified in 12 industrial branches. These are namely 'coal' and 'crude oil' in the fuels branch, 'iron ore' and 'manganese ore' in the ore-extraction branch, 'copper' and 'zinc' in the nonferrous metals branch, 'gold' in the gold-mining branch, 'lake-salt', 'evaporated salt' and 'rock salt' in the salt branch, 'pig iron', and 'iron and steel' in the ferrous metals branch, 'cotton yarn' and 'cotton cloth' in the cotton branch, 'raw sugar' and 'refined sugar' in the sugar branch, 'cigarettes' and 'makhorka' (low-grade tobacco) in the tobacco branch, 'matches' in the match-manufacturing branch, 'distilled liquor' in the distillery branch and 'yeast' in the yeast-manufacturing branch.

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[3] According to Kholodilin (К. Холодилин), other than the Kodratieff and Kafengauz indices shown in Table I , another index was compiled in the 1920s by Pervushin (С. А. Первушин) ([17, стр.66-67]). The Pervushin index seems to have been constructed in the process of estimating Russian national income based on production in each productive sector such as industry, agriculture, and so on. However, Kholodilin pointed out that the description of weights by Pervushin was quite ambiguous and the number of products employed in the compilation was rather small.

[4] According to the paper [7, стр.12], the originator of the calculation method of the Kondratieff index was Gerchuk (Я. П. Герчук) of the Conjuncture Institute, and hence it might be appropriate to call it

Production data is not available for 'cotton yarn' and 'cotton cloth' for the years 1885-89 and 1913, for 'matches' for 1885-87, or for 'yeast' for 1885. Sources of the data are *Отчеты Горного Департамента* (*The Report of the Mining Department,* [10]) for mining products and metals, *Статистика производств, обложенных акцизом* (*Statistics on Excise-Levied Commodities*, [14]) for 'raw sugar', 'refined sugar', 'cigarettes', 'makhorka', 'matches', 'distilled liquor' and 'yeast', and *Материалы для статистики хлопчато-бумажного производства за 1890-1900 г.* (*Materials for Statistics on the Cotton Production from 1890 to 1910*), *Статистика бумагопрядильного и ткацкого производства за 1901-1910 г.* (*Statistics on the Cotton Spinning and Weaving Production from 1901 to 1910*) and *Фабрично-заводская промышленность Европейской России* (*The Factory Industry in European Russia*) for 'cotton yarn' and 'cotton cloth'. It was claimed that the number of workers engaged in the production of these 21 items in 1900 amounted to 1,269,500, which accounted for about 53% of the entire industrial labour force. On the calculation of the index the output of these products in physical terms in each year was transformed into index numbers (the output in 1900 = 100).

Ⅰ-2. Weights

The weight system in the Kondratieff index is noteworthy: it is based on data for horsepower and number of workers employed in 1900. More precisely, the weight for a product represents an unweighted arithmetic average of two weights, one of which is the share of the product in the total horsepower of machinery involved in the production of all sample items, and the other is the share of the product in the total number of workers employed in the production of all sample items. The weight can be regarded as a surrogate indicator of unit value added of a sample commodity. This method had been developed by the Conjuncture Institute to compile a production index for Soviet industry.

In the actual calculations, data on horsepower was not available for the tobacco, match-manufacturing, distillery and yeast-manufacturing branches. For these branches only the share of the branch in the total number of workers was used as weight for the branch. For the tobacco branch in particular, only data on the combined number of workers engaged in the production of both 'cigarettes' and

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the Gerchuk index rather than the Kondratieff index.

‘makhorka’ was available, and hence half the share of the labour force of the whole tobacco branch was assigned to each of the two products. In addition, for the cotton branch, although data on horsepower for the entire branch was available, the individual figures on the two products of the branch, ‘cotton yarn’ and ‘cotton cloth’, were not available. Hence the weight of horsepower of the cotton branch was divided based on the share of workforce for the two products. The same procedure was applied also to ‘pig iron’, and ‘iron and steel’ in the ferrous metals branch and ‘raw sugar’ and ‘refined sugar’ in the sugar branch.

Table 2 Sample products and their weights in the Kondratieff index

Branch	Fuels		Ore-extraction		Nonfer. metals		Gold	Salt		
Product	Coal	Crude oil	Iron ore	Manganese ore	Copper	Zinc		Lake salt	Evaporated salt	Rock salt
Weight	7.7	6.6	2.4	0.2	0.5	0.1	3.6	0.7	0.2	0.1

Ferrous metals		Cotton		Sugar		Tobacco		Matches	Distilled liquor	Yeast
Pig iron	Iron & steel	Cotton yarn	Cotton cloth	Raw sugar	Refined sugar	Cigarettes	Makhorka			
8.6	23.1	12.0	18.2	7.5	1.2	1.55	1.55	1.4	2.6	0.2

Source: [7, стр.19].

I -3. Production index for each year

Attention should be paid to the fact that each figure of the original Kondratieff index is a geometric mean of index numbers of output of 21 sample products. The Kondratieff production index for the year *t*, namely *PI(t)*, can be written as follows.

$$PI(t) = \prod_j q_j(t)^{w_j / \sum w_j} \quad ,$$

where $q_j(t)$ denotes the production index of the sample product *j* for the year *t*, and w_j, the weight for the product *j* ($j = 1, 2, \cdots, 21$).

One of the reasons for the employment of a geometric average rather than an arithmetic average was that in the case of an index based on an arithmetic average an alteration in the reference year can result in changes in growth rates. The value of the Kondratieff index for 1895, for example, is 64.5, which is the geometric average of sample products’ indices whose reference year is 1900. Therefore the growth rate for the 5 years (1895-1900) is 55.0% ((100-64.5)/64.5). This growth rate is kept unchanged even when all the indices of sample products are altered with the shift of the reference year from 1900 to, say, 1895. This does not hold for the case of an arithmetic average. When we calculate production index for industry as a whole, using actual Kondratieff's data and an arithmetic mean with the reference year of 1900, we obtain 66.5 as the value for 1895[5]. This means the 5 year growth rate is equal to 50.4%. When we shift the reference year to 1895, we obtain 159.6 as the index number for 1900, which means that the growth rate is 59.6%, much greater than the rate calculated above (this point will be explained again based on hypothetical figures in Ⅱ-3 below). Due to the shortcomings involved in the use of an arithmetic average, a geometric average was selected in the Kondratieff index[6].

Ⅱ. The Goldsmith index

With rare exceptions, such as the Kafengauz or Pervushin indices, most numerical studies on the development of industrial production for Tsarist Russia were based on the Kondratieff index. The production index for Russia, for example, shown in the book *Industrialization and Foreign Trade*, published in 1945 by the League of Nations, was essentially the same as the Kondratieff index with minor alterations ([23, pp.132-134])[7]. In his well-known paper on the industrialization of Russia, Alexander Gerschenkron adopted the Kondratieff index almost as it was, only shifting the reference year from 1900 to 1913[8].

It was Goldsmith's paper, published in 1961, that changed the situation[9].

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5) The figure of 66.5 is based on the author's computations. This value is different from the figure shown in Table 16 (67.3), which is a recalculation by Goldsmith of the Kondratieff index. This might represent a computation error by Goldsmith.

6) According to Goldsmith ([20, p.455]), calculation methods of the Kondratieff index are explained more in detail in the paper by Gerchuk (Я. П. Герчук. in *Вопросы конъюнктуры*, vol.2, 1926), which, to my regret, I have never seen.

7) Citing industrial production indices for 15 countries including Russia, the League of Nations mentions a paper, published by Dessirie in 1928 and another paper, published in 1933 by Rolf Wagenführ, as sources of these indices on these countries before 1913 ([23, pp.126-127]). The League of Nations' index for Russia designates the values of 13 and 17 for the years 1870 and 1880, respectively, when the index number for 1913 is fixed at 100 (if the index for 1900 is put at 100, then 22 for 1870 and 29 for 1880).

8) Gerschenkron's evaluation towards the Kondratieff index is as follows. "…despite its obvious inadequacies, the (Kondratieff) index is undoubtedly the best statistical series of industrial production in prewar Russia. It should be remembered that it was prepared under the supervision of one of the most outstanding Russian economists and statisticians" ([19, pp.145-146]).

9) The paper published in the journal *Economic Development and Cultural Change* is said to be a condensed version of an original paper, which was written in 1956 and distributed within a limited range. According to Goldsmith, the basic work on indices of industrial (and agricultural) production for Russia was done by Murray Yanowitsch and Israel Borenstein, who were at that time on the staff of the National Bureau of Economid Research ([20, p.441]). To my regret, I have never seen the original paper.

The problems with the Kondratieff index pointed out by Goldsmith are as follows.

① The subject period for the production index is short.

② Despite the fact that an arithmetic average is generally employed to calculate a production index, the geometric form of averaging is adopted (Goldsmith actually calculated values, applying an arithmetic mean to the data underlying the Kondratieff index (see Tables 4 and 16)).

③ The calculation method of weight is arbitrary. As stated earlier an unweighted average of the shares of a product in total horsepower and labour force is the weight for the product in the Kondratieff index. But, according to Goldsmith, the weight assigned to horsepower (machinery) may be too heavy, if the estimation period is taken into consideration.

④ The year 1900 is adopted as the sole base year in the estimation, although massive changes in industrial structure are thought to have taken place during the estimation period.

⑤ The procedure of "imputation" – which is explained below – is made only for 'pig iron', and 'iron and steel' in the ferrous metals branch and 'crude oil'. The weights for 'pig iron', and 'iron and steel' in Table 2, for example, correspond to the total number of horsepower and workers employed, not in the production of these two products, but in the production of all commodities produced by the ferrous metals branch. Similarly, the weight assigned to 'crude oil' consists of horsepower and labour force employed not only in the production of crude oil but also in the production of oil products. Such an adjustment is called an imputation. This procedure is only applied to these three items in the compilation of the Kondratieff index, disregarding other commodities or branches. Taking these problems into account, Goldsmith compiles a new production index as follows.

Ⅱ-1. The estimation period and sample products

Goldsmith extended the estimation period back to 1860. While his index appears to employ almost the same sample products as those of Kondratieff's[10], there is no explicit explanation in his 1961 paper of how he obtained data on physical output for these products for 1860-1884. It would be difficult to secure all

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[10] According to Goldsmith, the single significant alteration was the adoption of 'raw cotton consumption' as a sample item instead of 'cotton yarn' and 'cotton cloth' ([20, p.458]).

this data from the literature introduced in I -1 as sources of production data for the Kondratieff index.

Ⅱ−2. Weights and base years

Goldsmith, who thought that the weight system of the Kondratieff index was more or less arbitrary, employed "value added" weight for each product or each industrial branch, and also adopted an arithmetic mean as the form of averaging. In addition he fixed the base years of estimation not only at 1900, but also at 1887 and 1908, and linked these three index series to obtain a final index. More specifically, the index with value added weights for 1887 was adopted for 1860-1887; the index with value added weights for 1900 was adopted for 1887-1900; and the index with value added weights for 1908 was adopted for 1900-1913. It seems that for 1887 and 1900, when two indices are overlapping, an average of the two index numbers is employed (see footnote 11 below). The two years 1900 and 1908 are the year of national census for industry, which was conducted only twice in pre-revolutionary Russia. According to Goldsmith, value added figures for 1887 were based on *Свод данных о фабрично-заводской промышленности России за 1897 год* (Collection of Documents on the Russian Factory Industry for 1897, [11-2]), and value added figures for 1900 and 1908 were derived from *Динамика российской и советской промышленности в связи с развитием народного хозяйства за сорок лет* (Dynamics of the Russian and Soviet Industry in Connection with the Economic Development for Forty Years, [1-1] [1-2]), written and edited by renowned economists, such as V. G. Groman, B. A. Bazarov or L. B. Kafengauz in early Soviet times.

Goldsmith calculated two types of series for each of three basic indices: a series with imputed weights and a series without the adjustment for imputation. The former means a series based on value added for each industrial branch to which a group of sample products belongs. Table 3 shows both imputed and unadjusted value added weights claimed in his paper to be applied to each industrial branch in the compilation of the production index for industry as a whole. Calculation results are shown in Table 4 and Table 16 below.

If we compare the unadjusted figures of the Goldsmith index for 1900 shown in Table 3 with the weights of the Kondratieff series displayed in Table 2, we can see the former figures are much smaller than those of the latter for the ferrous and nonferrous metallurgy, whereas the opposite holds for mining and food. The similar tendency can be observed for imputed weights except for mining products, where the weight for them is almost the same as in the Kondratieff index. Concerning historical changes in value added shares, there seem tendencies of an increase and a subsequent decline for the mining and metals branches, a decrease and a subsequent increase for the cotton branch, and a decline and a subsequent stabilization for the food industry.

Table 3 Imputed and unadjusted value added weights for each industrial branch in the Goldsmith index

	1887		1900		1908	
	imputed	unadjusted	imputed	unadjusted	imputed	unadjusted
Mining	12.6	26.9	18.2	32.7	16.9	31.9
Metals	19.6	15.7	28.0	19.4	22.3	11.3
Cotton	36.7	28.8	26.0	22.7	31.3	31.1
Food	28.4	27.1	22.2	21.7	22.2	23.0
Matches, Oil products	2.7	1.5	5.6	3.5	7.3	2.7
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: [20, p.461].

Ⅱ−3. Some considerations

Table 4 Average annual growth rates of the indices by Goldsmith (%)

	Kondratieff		Goldsmith							
			1887 weight		1900 weight		1908 weight		link	
	Arith. mean	Geo. mean	Im-puted	Unad-justed	Im-puted	Unad-justed	Im-puted	Unad-justed	Im-puted	Unad-justed
1860-1875	3.2	5.1	3.1	3.0	3.0	3.2	3.1	3.2	3.1	3.0
1875-1888	4.2	6.0	4.7	4.4	5.4	5.4	5.6	5.4	4.9	4.5
1888-1900	7.5	8.6	7.9	7.3	7.3	6.9	7.5	7.0	7.6	7.1
1900-1913	4.1	3.9	4.0	4.0	3.9	3.7	3.6	3.5	3.6	3.5
1860-1888	3.7	5.5	3.8	3.6	4.1	4.2	4.3	4.2	4.0	3.7
1888-1913	5.7	6.1	5.9	5.6	5.5	5.3	5.4	5.2	5.5	5.2
1860-1913	4.6	5.8	4.8	4.5	4.8	4.7	4.8	4.7	4.7	4.4

Note : Calculated by the author from [20, pp.462-463]. Growth rates are computed based on the formula $Y_t=Y_0(1+\alpha)^t$, where Y_0 denotes the value for the initial year, Y_t, the value for the t-th year, α, the growth rate. Most of growth rates in this paper are computed based on this formula. When growth rates are calculated in other ways, notes are given to that effect.

Utilizing original data for the Kondratieff index and extending them back to 1860, Goldsmith calculated arithmetic and geometric average indices, and compared them with his own series. Table 4 shows average annual growth rates computed from these indices.

Generally speaking, growth rates from an index whose base year is set in the remote past are expected to have greater values than those from an index whose base year is closer to the present. This phenomenon manifests itself especially in the stage of rapid industrialisation (the Gerschenkron effect), although the results by Goldsmith do not demonstrate this point clearly. It is true that for 1888-1913 the highest growth rates are yielded by the series with the 1887 weight (5.9% and 5.6%) and the lowest rates are brought about by the series with the 1908 weight (5.4% and 5.2%). The same holds for a shorter period between 1900-1913. The rule does not apply, however, for other periods of time, or for the entire estimation period, which seems to have caused Goldsmith some embarrassment. Ultimately these results might indicate that the Gerschenkron effect emerges clearly when taking product prices as weights, but not so definitely when adopting value added as weight. In fact in the author's estimation, where shares of labour force are taken for each industrial branch as weights, the later the base year is set, the larger are growth rates of indices, as displayed in Table 14 below.

Next we examine the issue of reference year. Let us suppose that values in an index are increasing with the passage of time. Generally values based on a geometric average are smaller than those based on an arithmetic average ([22, pp.16-18]). Therefore if we fix the reference point of time at the present time and average future index values, then it is expected that growth rates from an index with an arithmetic mean are greater than those from a geometric mean, and conversely if we average past index values, then growth rates from an arithmetic mean are smaller than those from a geometric mean. Since the reference year is fixed at the year 1900 in the calculations by Goldsmith, growth rates of the recalculated Kondratieff index based on a geometric mean are higher than those of the index based on an arithmetic mean for the years before 1900, lower for the years after 1900, and higher for the entire estimation period, as shown in Table 4. Also the Goldsmith index, where an arithmetic mean is adopted, generally shows lower growth rates than the Kondratieff index with a geometric mean, but there seem to be no substantial differences between the Goldsmith and the arithmetic mean Kondratieff indices. Average growth rates from 1860 to 1913 in the 8 Goldsmith series are distributed in the range of 4.4% to 4.8%, showing also no considerable differences[11].

As stated earlier, the composite indices by Goldsmith seem to be based on individual indices whose reference year is 1900. This procedure causes one problem. To explain this issue a simplified example in which hypothetical figures are taken is exhibited in Table 5. Let us think of the case in which we compile a composite index by averaging two individual indices with the weight of 1:1, as is given in the table. Goldsmith probably is thought to have computed a composite index by averaging individual indices whose reference year is 1900 with an arithmetic mean, like case (1) in the table, to obtain his final index. In the case of the table the average annual growth rate of the composite index is calculated as 4.04%. But if we fix the reference year of the two indices, not at 1900, but at 1860, and compute a composite index in the same way, then we obtain an annual rate of 4.54% (case (2)). And if we set the reference year at 1913, then we get a rate of 3.91%. That is, if the reference year is set at the first year of the series whose values are increasing, then the arithmetic averages of values from the reference year onwards are greater than the geometric averages, and hence higher growth rates are yielded. Conversely if the reference year is set at the last year, then the arithmetic averages are greater than the geometric averages, and we obtain

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[11] When Goldsmith compiled his final index, linking 3 index series whose base years were 1887, 1900 and 1908, respectively, he seems to have linked the 1887 weight series and the 1900 weitght series in the year 1888, and the 1900 weight series and the 1908 weight seires in the year 1900. The table below shows how he actually computed the link index, taking the example of connecting the 2 imputed series in the year 1888. In both series the value for 1900 is 100. When these two series are linked, it seems that the values of the 1887 series are adopted exactly as they are for the years before 1886, the values of the 1887 series and of the 1900 series are averaged with the weight of 3:1 for the year 1887, with the weight of 1:1 for the year 1888, and with the weight of 1:3 for the year 1889, and the values of the 1900 series are adopted as they are for the years after 1890.

But, the method of linking two index series is not limited to the above-mentioned way. As is shown the series (b) in the table, for example, the method can be also appropriate that the 1900 series is adopted for 1888-1900, and the 1887 series is accepted after performing proportional calculations for the years before 1887. In the case of this method average annual growth rate for 1860-1913 of the imputed link index is 4.6%, slightly lower than Goldsmith's corresponding series.

	1885	1886	1887	1888	1889	1890	1891
The 1887 series	37.6	38.9	43.6	40.3	44.1	47.8	50.1
The 1900 series	39.2	40.3	45.1	43.0	47.2	50.7	53.4
Link index (a)	37.6	38.9	43.6 ×3/4+ 45.1×1/4= 44.0	40.3×1/2+ 43.0×1/2= 41.6	44.1×1/4+ 47.2×3/4= 46.4	50.7	53.4
Link index (b)	43.0× 37.6/40.3= 40.1.	43.0× 38.9/40.3= 41.5	43.0× 43.6/40.3= 46.5	43.0	47.2	50.7	53.4

relatively smaller growth rates. On the other hand, if we take the geometric averages of the two individual indices as a composite index, we get an unchanged value of 4.22% as an average growth rate irrespective of the reference year, as is shown in the table.

In the light of this point, the Goldsmith index seems to have a slight tendency towards underestimation, since its reference year is set at 1900, which is rather close to the last year of the estimation period. If we accept Goldsmith's emphasis that arithmetic averaging is a traditional practice for the compilation of a production index, then a device may be needed to avoid such a bias.

Table 5 Composition of indices (an example of hypothetical figures)

		1860	1900	1913	Average annual growth rates(%)
Case (1) reference year: 1900	Individual index (a)	10.0	100.0	160.0	
	Individual index (b)	25.0	100.0	125.0	
	Com. Index (arith. mean)	17.5	100.0	142.5	4.04
	Com. index (geo. mean)	15.8	100.0	141.4	4.22
Case (2) reference year: 1860	Individual index (a)	100.0	1000.0	1600.0	
	Individual index (b)	100.0	400.0	500.0	
	Com. Index (arith. mean)	100.0	700.0	1050.0	4.54
	〃 (the year 1900=100)	14.3	100.0	150.0	4.54
	Com. index (geo. mean)	100.0	632.5	894.4	4.22
	〃 (the year 1900=100)	15.8	100.0	141.4	4.22
Case (3) reference year: 1913	Individual index (a)	6.3	62.5	100.0	
	Individual index (b)	20.0	80.0	100.0	
	Com. Index (arith. mean)	13.1	71.3	100.0	3.91
	〃 (the year 1900=100)	18.4	100.0	140.4	3.91
	Com. index (geo. mean)	11.2	70.7	100.0	4.22
	〃 (the year 1900=100)	15.8	100.0	141.4	4.22

Note: "Com." stands for "composite." Composite index (arithmetic mean) means an index whose numbers are an arithmetic average of the values of index (a) and index (b) for each year. Composite index (geometric mean) means an index whose numbers are a geometric average of the values of index (a) and index (b) for each year. The weight ratio of index (a) and index (b) is 1:1 in every case.

Ⅲ. Estimation methodology

As stated earlier, at present the Goldsmith series seems to be the most reliable index of industrial production for pre-Revolutionary Russia. In his index, however, the number of products on which it is based is not many, and also the index is thought to have a slight downward bias. The following is the author's estimation. Taking the data availability into consideration the estimation period is set from 1860 through 1913, as is Goldsmith or Nutter.

Ⅲ−1. Outline

Compared with Kondratieff's or Nutter's estimations, where physical output of industrial products was multiplied with their value added weights and aggregated to obtain a production index for industry as a whole, the estimation method in this paper is made up of two steps. The first step is the calculation of real production indices for industrial branches, and the second is the aggregation of the branch indices to obtain an index for entire industry. This is essentially the same method as the author adopted in the compilations of production indices for the Soviet or Soviet-Russian industry (see [16] [25-1] [25-2] [25-3] [26-1] [26-2] [26-3]). Goldsmith seems to have adopted basically the same method, since he took the issue of imputation into consideration. But he did not explicitly compute branch indices.

At the first stage of the author's estimation, where branch indices are calculated, prices for sample products in a base year are employed as weights with which physical output volumes of the products are aggregated. In other words the total production values are computed by branch, and in this sense our branch index can be called an indicator of "gross output." Value added weight is not employed, because the data needed to calculate it was not available. For the "value added" of Kondratieff, there is the problem which Goldsmith pointed out, and for the "value added" of Goldsmith, the method of its derivation was not specified in his paper. In addition the value added estimation would be difficult to derive from the literature referred to by Goldsmith, unless rather bold assumptions are accepted. I will return to this issue in Ⅲ-6 .

At the second stage of the estimation branch indices are aggregated to obtain an index for industry as a whole, as mentioned above. The shares of workers for each branch in total labour force in industry are employed as weight. Although it may be desirable here also to use a value added weight for the branch, labour force is substituted owing to the lack of data.

Ⅲ−2. Data on products and branch classification

As far as industrial statistics in Tsarist Russia are concerned, the consolidation of statistics in itself was not the purpose of the government. In fact the statistics at that time were only a by-product of factory inspection and tax collection. Hence the collection of production data was not necessarily conducted systematically and exhaustively[12]. As a result the number of industrial products whose physical output data is available for our statistical research is limited. In the Kondratieff index 21 items (19 if we take three kinds of salt as one product) were used in the estimation, while Goldsmith employed only 18 products in his compilation. In contrast, Nutter collected many more products — 26 items. In this paper's estimation 31 products have been used, depending basically on Nutter's production data, with the addition of several products. The author's data covers mining as well as the so-called factory industry in the territory of the Russian Empire including Poland and *Pribaltika*, but excluding Finland. Handicraft (*remeslo* and *kustarnichestvo*) is not included in the estimation in this paper. These qualifications are identical with those of Kondratieff, Goldsmith or Nutter. Annual production data added in the estimation, unfortunately, contains substantial numbers of blanks, as shown in Table A-1 in Appendix I .

Table 6 compares production data employed in the estimations cited in this paper. Let us first compare the author's sample products with those of the Kondratieff-Goldsmith estimate. Since there are many unknown points in the estimation of Goldsmith for 1860-1885, the data is compared for the latter half of the estimation period, 1885-1913. In my estimation the products of the chemical and construction materials branches are added to the sample products of the Kondratieff-Goldsmith indices. While the latter already includes 'matches' as a product of the chemical industry, five items of 'phosphorite fertilizer', 'sulphuric acid', 'soda ash', 'white lead' and 'zinc oxide' are added in this paper. In addition three kinds of products in the construction materials branch — 'cement', 'bricks' and 'window glass', — which were not used in the Kondratieff-Goldsmith estimate, are adopted in this paper. Growth rates for these 8 products except for 'zinc oxide' exceed the average growth rate for the sample products of the Kondratieff-Goldsmith index, which may lead to a conclusion that growth rates derived from the estimation in this paper surpass those of the Kondratieff-Goldsmith index. As is shown later, however, the weights given to the chemical and construction materials branches are relatively small, and hence the influence of these branches to the index for entire industry does not seem significant.

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[12] See, for example, Tomioka [27, Chapter 4, paragraghs 1 and 4].

In addition to the aforementioned 8 products, 'iron' and 'steel', which were combined as one product in the Kondratieff-Goldsmith index, are separated in this paper, and 'rails' are included in the author's estimation. 'Vegetable oil', 'flour', 'starch and syrup' and 'beer' are added to the food branch, and 'woollen yarn' is included in the textile branch. Conversely, 'salt', which was divided into three products in the Goldsmith index, is unified as one item in this paper's estimation, and 'iron ore', 'manganese ore' and 'yeast' are dropped in my estimation. As a result of these changes, the simple average of annual growth rates for this paper's sample products in the period from 1885 to 1913 is 6.3%, whereas that of the Kondratieff-Goldsmith index was 5.0%.

Table 6 Comparison of output data

	Suhara		Kondratieff-Goldsmith		Nutter		Kafengauz	
	Growth rate	Number of products	Growth rate	Number of products	Growth rate	Number of products	Growth rate	Number of products
1860-1885	7.3	20			8.5	17		
1885-1913	6.3	31	5.0	21	6.9	26	7.5	29
1860-1913	6.2	20			7.3	17		

Note: Calculated by the author from data shown in [7, стр.19], [24, pp.411-415] and [5, стр.290-297, 355-356, 362-363, 369-371, 377-378, 388-389, 395-400]. "Growth rate" in the table means a simple arithmetic average of annual growth rates of sample products in each estimation. A geometric mean is not employed here because growth rates for some sample products are negative. In the calculation of growth rates of the Suhara and Nutter indices for 1860-1885 and 1860-1913, the output for 'phosphoric fertilizer', 'white lead' and 'zinc oxide' was excluded, since the output of the three products for 1860 was zero. Goldsmith seems to have employed almost the same data as Kondratieff for 1885-1913. Nothing is known on details of output data used by Goldsmith for 1860-1885. Although Nutter did not specify the weight for one commodity ('starch and syrup') ([24, p.535]), that item seems to have been included in his estimation. The initial year for the Kafengauz estimation is not 1885, but 1887.

Nutter's index, like the index in this paper, is an estimation for the period of 1860-1913, and he specifies in his book all the physical output data of sample products for the entire estimation period. In comparison with the products in the Nutter estimation, the five important items of 'pig iron', 'iron', 'gold', 'matches' and 'refined sugar' are added in this paper. Since growth rates of output of these products are relatively slow, the average growth rate of the samples in this paper is smaller than that of Nutter's index, as is displayed in Table 6. The author's index indicates substantially slower growth for the first half of the estimation period than those of Nutter's (see Tables 16 and 17 below), one of the reasons for which can be the inclusion of the above-mentioned products in the estimation.

Table 7 Prices for industrial products (rubles)

			Unit	1890	1900	1908	1912
Fuels	Crude oil	Нефть	ton	1.83	9.58	13.6	21.6
	Coal	Каменный уголь	ton	3.05	3.94	4.73	5.16
Ferrous metals	Pig iron	Чугун	ton	42.7	33.5	26.6	38.2
	Iron	Железо	ton	97.7	90.5	93.5	98.8
	Steel	Сталь	ton	73.4	66.2	58.4	54.2
	Rails	Рельсы	ton	98.1	88.5	61.4	69.2
Nonfer. metals	Copper	Медь	ton	739.2	857.7	798.4	877.9
	Lead	Свинец	ton	145.5	177.6	185.5	214.6
	Zinc	Цинк	ton	258.8	222.9	231.0	284.7
	Gold	Золото	kg	1160.0	1236.0	1460.2	1625.9
Chemicals	Phosphoric fertilizer	Фосфорные удобрения	ton	12.2	9.82	—	28.1
	Sulfuric acid	Серная кислота	ton	49.2	36.0	30.3	41.9
	Soda ash	Кальцинированная сода	ton	55.0	46.2	76.3	49.7
	White lead	Свинцовые белила	ton	216.4	200.8	228.9	272.7
	Zinc oxide	Цинковые белила	ton	221.0	244.8	254.0	304.0
	Matches	Спички	millions	41.6	40.7	39.7	34.0
Con. mat.	Cement	Цемент	ton	23.2	17.2	17.8	19.8
	Bricks	Кирпич	thousands	11.2	11.7	13.0	15.3
	Window glass	Оконное стекло	m^2	0.80	0.42	0.51	0.40
textile	Ginned cotton consumption	Потребление хлопка-волокна	ton	512.7	601.5	786.3	762.8
	Woollen yarn	Шерстяная пряжа	ton	1862.3	2292.7	2579.8	2728.0
Food	Raw sugar consumption	Сахар-песок, потребление	ton	153.8	142.4	129.1	134.3
	Refined sugar	Сахар-рафинад	ton	256.4	253.4	223.0	189.2
	Vegetable oil	Растительное масло	ton	226.8	296.0	263.4	300.9
	Flour	Мука	ton	65.4	67.8	98.5	94.2
	Starch & syrup	Крахмал и патока	ton	32.5	108.2	118.4	90.1
	Crude alcohol (100%)	Спирт-сырец	kl	122.0	112.2	106.8	103.6
	Beer	Пиво	kl	—	70.7	72.5	73.1
	Salt	Соль	ton	6.91	4.12	5.24	5.48
	Cigarettes	Папиросы	thousands	—	—	1.47	1.67
	Makhorka	Махорка	20kg crates	—	—	1.22	1.39

Note: — means 'not available'.

Source: Calculated by the author. See Appendix Ⅱ in this paper.

Table 6 shows that the average growth rate of output of sample products in the Kafengauz index is the highest among the estimates discussed here. His estimation, whose purpose was to measure the growth of industrial production in the territory of the Soviet Union, excludes Poland and Pribaltika. Industrial production in these areas grew relatively slowly during the period from the late 19th to the early 20th century. As Paul Gregory pointed out ([4, стр.483]), this fact can be responsible for the fast growth of industrial production the Kafengauz index indicates.

31 industrial products employed as samples in this paper are classified into seven branches, as is shown in Table 7. Namely, they are the fuels, ferrous metals, nonferrous metals, chemicals, construction materials, textiles, and food branches. This branch classification is based on the method used in Soviet times rather than the method used at that time. While details of the classification are explained in the note for Table 9, the ferrous and nonferrous metals branches, which were lumped together under the metals branch in Tsarist Russia's statistics, are treated in this paper as two individual branches, and the ore extraction of various metals is assigned to each of the two metals branches. In addition 'salt', which was classified into mining, is incorporated in the food industry in the estimation in this paper. The construction materials branch, which is the designation in Soviet times, was at that time called the ceramics (керамическая) or silicate (силикатная) branch. On the other hand, while in Soviet statistics 'oil products', 'matches' and 'rails' were classified into the fuels, wood processing and construction materials branches respectively, the former two items are assigned in this paper to the chemical industry and the latter, to the ferrous metallurgy, as was common at that time.

Ⅲ-3. Prices for industrial products

As stated earlier, prices for sample products, specifically prices in 1890, 1900, 1908 and 1912, are employed as weights at the first stage of the estimation. In other words, 4 series of production indices for each branch are calculated on the basis of these 4 sets of prices. As a result of difficulties in collecting prices for the first half of the estimation period, base years tend to relate to the second half.

The prices were estimated by the author as an average wholesale price from which indirect tax (excise) was deducted, namely, as a factory shipment price excluding transportation costs. Concrete methods of estimation are stated in Appendix Ⅱ at the end of the paper. Table 7 shows these prices.

In this paper each branch index was computed as follows. As shown in the left half of Table 8, the series in which production values are indexed on the basis of the 1890 prices is utilized for 1860-1895, the 1900 series for 1895-1905, the 1908 series for 1905-1910, and the 1912 series for 1910-1913. Each Laspyres-type production index calculated in this way is connected at the three link years (1895, 1905, and 1910) by means of proportional calculations. Although such a period division may be arbitrary, generally for the link years more samples are used in calculations of index numbers than for other ordinary years, which makes the figures for the link years more reliable. Calculation results of branch indices are shown in Table 12 below.

Table 8 Calculation methods of index

Calculation of branch index		Calculation of index for total industry	
1860-1895	The 1890 price series	1860-1887	The 1887 workforce series
1895-1905	The 1900 price series	1887-1895	The 1890 workforce series
1905-1910	The 1908 price series	1895-1905	The 1900 workforce series
1910-1913	The 1912 price series	1905-1910	The 1908 workforce series
		1910-1913	The 1912 workforce series

Note: The connection of index numbers of different series is made by means of proportional computations.

Ⅲ-4. Workforce shares

The next step, the second stage of the estimation, is the aggregation of production indices for industrial branches calculated in the first stage to obtain an index for entire industry. The shares of workers for each branch in the total workforce are employed as weight with which branch indices are aggregated. In the aggregation of branch indices arithmetic averaging is adopted following Goldsmith's example. Taking changes in industrial structure over the estimation period into consideration, workforce shares are picked up for five years, namely, for 1887, 1890, 1990, 1908, and 1912. The year 1887 is added as a base year to the four base years for prices in order to reflect in the index the production structure of a year as far back as possible. Here too, base years incline towards the latter half of the estimation period owing to the data availability. Thus five production index series are obtained.

Methods for the connection of the five series are almost the same as the first stage, as shown in the right half of Table 8. For 1860-1887 a composite index is adopted of branch indices aggregated based on the labour force weight for 1887, for 1887-1895 a composite index with the 1890 weight is used, for 1895-1905 a composite index with the 1900 weight is used, for 1905-1910 a composite index with the 1908 weight is used, and for 1910-1913 a composite index with the 1912 weight is used. For some years branch indices are available not for the seven branches mentioned above, but only for five or six branches, due to the lack in physical output data. In these cases workforce shares are utilized in terms of the total workers, excluding branches whose output data is missing. At each of the four link years (1887, 1895, 1905, and 1910) the two composite indices are connected by means of proportional computations to obtain a final index of industrial production. The five composite indices and the final one are shown in Table 14 below.

A problem arises, when the five composite indices are calculated from branch indices: at which point of time should the reference year be fixed in branch indices? If branch indices with the reference year of 1900 are selected, as in Goldsmith, the possibility of a downward bias comes up in the final index for entire industry, as pointed out earlier. This bias could be rectified, if the central year of the estimation period is taken as the reference year. However, for 1886 or 1887 we can not compute index numbers for the construction materials or chemical branches due to the lack of physical output data on samples (see Table 12 below), and hence these branches can not be included in the final index. In this paper therefore the following method is employed. Branch indices are first given as 100 for every five years, and then they are aggregated to obtain composite indices. For example, a branch series is expressed for 1860-1865 as index numbers with the reference year of 1860 (that is, as an index whose value for 1860 is set at 100), for 1866-1870 as index numbers with the reference year of 1865, and so on, and then these branch indices are averaged with the weight of workforce shares for each branch to obtain an index for entire industry. Comparisons of the index by this method with the Goldsmith index are shown in Ⅳ-1.

As mentioned above, at the first stage of the author's estimation branch indices are decided, and then used to decide five production series for total industry. Finally a final index is obtained by linking the five series. However, another method of acquiring a total index may be practicable. Namely, at the first stage four index series are compiled based on the four sets of base year prices for each branch, and then workforce weights for the four base years are applied to corresponding branch indices to get four series for entire industry. A final index is acquired by linking the four series. With this procedure, however, we cannot utilize data on labour force for 1887. In addition calculation results on the basis of this procedure are almost identical to those of the method employed in this paper.

Concrete figures of workforce weights for industrial branches for the five base years are shown in Table 9. While the main industrial branches in Tsarist Russia from the viewpoint of labour force can be said to be the textile and food industries throughout the estimation period, weights for each branch obviously changed with the passage of time. The change in workforce shares between 1887 and 1890, on the one hand, and 1900 and after, on the other, is remarkable. While the workforce share for the fuels branch increased significantly over the two periods, the shares for the ferrous and nonferrous metallurgy substantially decreased. Also the share for the food industry gradually declined. As a result of the changes in labour force growth rates from the indices on the basis of the 1900, 1908 and 1912 weights are slightly higher than those of the 1887 and 1890 weights, as shown in Table 14 below. As opposed to the above-mentioned branches, the workforce weight for the textile branch, which remained to be the most important industrial branch in those days, shows very little change until 1912. The weight for the chemical and construction materials branches also displays no substantial increases.

Table 9 Labour force for each industrial branch (thousands)

	1887	%	1890	%	1900	%	1908	%	1912	%
Fuels	36.9	2.8	46.6	3.3	183.3	9.0	263.9	10.9	276.1	10.5
Fer. metals	223.5	17.0	234.0	16.4	200.3	9.8	180.7	7.5	201.2	7.7
Nonf. metals	99.4	7.5	105.1	7.4	108.4	5.3	96.8	4.0	109.2	4.2
Chemicals	29.0	2.2	36.1	2.5	60.7	3.0	71.3	3.0	68.1	2.6
Con. mat.	67.3	5.1	72.4	5.1	130.7	6.4	134.0	5.6	175.9	6.7
Textile	399.2	30.3	433.3	30.4	619.3	30.3	771.1	31.9	800.5	30.6
Food	254.2	19.3	255.8	17.9	315.4	15.4	396.1	16.4	329.4	12.6
Total for 7 br.	1109.5	84.2	1183.2	83.0	1618.1	79.2	1914.0	79.3	1960.3	74.9
Total indusry	1318.0	100.0	1425.9	100.0	2042.9	100.0	2413.8	100.0	2618.6	100.0

Note: Sources of data and calculation methods are as follows. For the years 1887 and 1890: [11-2, стр. II -XXI]. 'Fuels' denotes the total number of workers who were engaged in the production of ископаемый уголь (coal) and нефть (crude oil); 'ferrous metals' denotes the total of чугун (pig iron), железо (iron), сталь (steel), железная руда (iron ore), марганцовая руда (manganese ore), хромистый железняк (chrome ore), and серный колчедан (pyrites); 'nonferrous metals' denotes the total of золото (gold), платина (platinum), серебро (silver), свинец (lead), медь (copper), цинк (zinc), ртуть (mercury), серебро-свинцовая руда (silver-lead ore), медная руда (copper ore), цинковая руда (zinc ore), and ртутная руда (mercury ore); 'chemicals' denotes the total of химические производства (chemical productions), переработка нефти (oil refining), and резиновое производство (rubber production); ‘construction materials' denotes керамические производства (ceramic productions); ‘textile’ denotes волокнистые вещества (textiles); 'food' denotes the total of питательные продукты (foodstuffs), поваренная соль (common salt), and табачное производство (tobacco production). For the years 1900, 1908 and 1912: [1-1, стр.96-97], [1-2, стр.78-87], and [1-3, стр.10-13], respectively. ‘Fuels’ denotes the total of каменноугольная промышленность (coal industry), нефтедобывающая (oil extraction), and торфяная (peat); ‘ferrous metals’ denotes the total of металлургия черных металлов (ferrous metallurgy), железная руда (iron ore), марганцовая руда (manganese ore), хромистая руда (chrome ore), and серный колчедан (pyrites); ‘nonferrous metals’ denotes the total of выплавка цветных металлов (nonferrous metallurgy), and золотоплатиновая промышленность (gold-platinum industry); ‘chemicals’ denotes химическая промышленность (chemical industry); ‘construction materials’ denotes силикатная промышленность (ceramic industry); ‘textile’ denotes the total of обработка хлопка (cotton), обработка шерсти (wool), обработка шелка (silk), обработка льна и прочих волокнистых веществ (flax and other textiles), and обработка смешанных волокнистых веществ и изделий из текстильных материалов (mixed textiles); ‘food’ denotes the total of пишевкусовая промышленность (food industry), and соляная промышленность (salt industry). Since for металлургия черных металлов (ferrous metallurgy) and выплавка цветных металлов (nonferrous metallurgy) in 1912 only data on the combined number of workers is available, the workers are divided up and assigned to the two branches according to the production values of each branch. Since total numbers of workers for entire industry for 1890 and 1912 in the above-listed sources seem to be wrong, the figures have been revised by the author.

Ⅲ−5. Representativeness of sample products

Before examining estimation results, let us clarify some points at issue in the author’s estimation in order to ascertain the validity of the calculations. Firstly we will investigate the issue of representativeness or coverage: to what extent sample products represent the production of industry as a whole. Table 10 shows the representativeness by industrial branch for 1908. An explanation follows of how this table was compiled.

The representativeness of sample products by branch can of course be measured by comparing the sum of the products of price multiplied by physical output for every sample within a branch, with the total value of production for the branch stated in the sources at that time (the book, for example, published by Bazarov *et al.* in the 1920s, [1]). Figures in Table 10 for the fuels, nonferrous metals, and construction materials branches are calculated in this way. For the other four branches, however, this method cannot directly be applied, because for some products part of the output was diverted to be used as materials for other products probably in the same factory. This part of the output was not included in the total value of production for the branch in industrial statistics at that time. According to the literature [1-2, стр.142-143], for example, 115,467,700 *puds* of pig iron, which accounted for about two thirds of the total output in 1908 of 171,054,400 *puds*, was utilised for the production of steel. This part was not counted as the total value of production for pig iron. Hence, if the price of pig iron is multiplied by its output, a value is obtained which greatly exceeds the value of production. Products of the ferrous metals, chemicals, textile, and food branches include many items of this kind. Table 10 displays the figures after the adjustments of excluding the portion which was utilised as materials for other products.

Table 10 Representativeness of sample products (%): 1908

branch	Fuels	Fer. metals	Nonf. metals	Chemicals	Con. Mat.	Textile	Food	Total industry
Sample products	Crude oil, Coal	Pig iron, Iron, Steel, Rails	Copper, Lead, Zinc, Gold	Phosphoric fertilizer, Sulfuric acid, Soda ash, White lead, Zinc oxide, Matches	Cement, Bricks, Window glass	Ginned Cotton consumption, Woollen yarn	Raw sugar consumption, Refined sugar, Vegetable oil, Flour, Starch & syrup, Crude alcohol, Beer, Salt, Cigarettes, Makhorka	
Representa tiveness(%)	88.8	25.9	95.1	6.1	43.7	23.5	59.7	35.1

Note: For compilation methods of the table, see the text. Sources of data on each industrial branch are as follows. 'Fuels': for price and output for each product, see Table 7 and Table A-1; for the total value of production for the branch, see [1-2, стр.107]. 'Ferrous metals': for the value of production for each product as part of the total value of production for the branch, see [1-2, стр.142-145]; for the total value of production for the branch, see [1-2, стр.78]. 'Nonferrous metals': for price and output for each product, see Table 7 and Table A-1; for the total value of production for the branch, see [1-2, стр.78, 107]. 'Chemicals': for the value of production for each product as part of the total value of production for the branch, see [1-2, стр.87, 186-187]; for the total value of production for the branch, see [1-2, стр.78]. 'Construction materials': for price and output for each product, see Table 7 and Table A-1; for the total value of production for the branch, see [1-2, стр.78]. 'Textile': for price and output for ginned cotton consumption, see Table 7 and Table A-1; for the value of production for woollen yarn as part of the total value of production for the branch, see [1-2, стр.260-261]; for the total value of production for the branch, see [1-2, стр.82, 86]. 'Food': for the value of production for each product as part of the total value of production for the branch, see [1-2, стр.107, 212-213, 220-221, 224-225, 228-229, 232-233, 236-237]; for the total value of production for the branch, see [1-2, стр.82, 107]. 'Total industry': for the total value of production, see [1-2, стр.108].

As shown in the table, the coverage of samples differs substantially among branches. For the nonferrous metals, fuels and food branches the total sum of the production value of sample products occupies more than 50%, whereas samples of the chemical branch cannot be said to fully represent the whole branch. Also the coverage is not satisfactory for the textile branch, which is represented by the two samples of 'ginned cotton consumption' and 'woollen yarn'. More data should be collected on price and output for products of these branches.

Ⅲ−6. Workforce and value added

While Goldsmith employed "value added" for each product as weight, the collection of data needed to derive value added from the literature he referred to seems problematic, as was stated earlier. It is true that for manufacturing (total industry includes mining as well as manufacturing) in 1900 and 1908, calculations of value added for each industrial branch can be made by deducting "material costs" from the "total value of production" based on the literature [1-1, стр.66-79], [1-2, стр.78-89]. Table 11 shows the comparison of value added weights obtained in this way with workforce weights.

Value added figures in Table 11, however, possess considerable defects. To begin with, the figures for 1900 do not include production data for Siberia and Turkestan. Also in the calculation of value added for 1900 much production data is not taken into account for various important items. For instance, the chemical branch does not contain production data for 'matches' and 'oil refining'. In the same manner the food branch does not include 'raw sugar', 'refined sugar', 'distilled liquor', 'yeast', 'wine', 'beer and *medovukha*', 'cigarettes', '*makhorka*' and so on. In addition most products of ferrous metallurgy and nonferrous metallurgy are not included in the calculation. Lastly production data for mining such as fuels and ore extraction is not available. On the other hand, although for value added for 1908 most products which are not included in the computation for 1900 are available, value added cannot be calculated for all the products in mining. Moreover, for 1887, 1890, and 1912, data on production costs, which is indispensable to the calculation of value added is not available. For the reasons mentioned above, workforce for branch, instead of value added, is used as weight in the estimation in this paper.

Although systematic data is not available from Table 11, it can be said that value added weights and workforce weights for each branch differ substantially. It could be a problem for the textile and food industries, whose weights are relatively heavy. On the whole, workforce weights for the textile branch are greater than its value added weights, whereas the opposite is true for the food branch. While the reason for this is not clear, growth rates for the food industry are smaller than those for the textile industry, as can be seen in Table 12. If we calculate a production index based on the value added weights, growth rates are expected to be slightly lower than those in Table 13.

Table 11 Value added and workforce in 1900 and 1908

	1900				1908			
	Value added (1000 rubles)	%	Workforce (persons)	%	Value added (1000 rubles)	%	Workforce (persons)	%
Fer. met.	—	—	—	—	88,847.1	5.5	147,038	7.3
Chemical	31,287.8	5.3	36,485	2.9	98,037.1	6.1	71,278	3.5
Con. mat.	46,253.2	7.8	127,970	10.0	62,024.3	3.9	134,011	6.6
Textile	235,755.5	39.6	612,307	48.1	421,303.3	26.2	771,137	38.2
Food	52,930.9	8.9	71,042	5.6	550,738.3	34.2	383,343	19.0
Total manufacturing	594,630.9	100.0	1,274,072	100.0	1,610,686.3	100.0	2,017,235	100.0

Note: Calculated by the author based on data in [1-1, стр.66-79], [1-2, стр.78-89]. — stands for "not available". The fuels and nonferrous metals branches are not available due to the lack of data. For calculation methods of value added, see the text. Only in this table the ferrous metals branch does not include ore extraction, and the food branch does not include the salt industry. The production of value added for 1900 does not contain that of Siberia and Turkestan. Also value added for chemical and food branches for 1900 does not include that of many important subbranches (see the text). Workforce data for branches or subbranches whose value added is not available are omitted in the calculation of the table.

Ⅲ-7. Branches not taken into account

While, as shown in Table 9 above, the seven branches taken up in this paper occupy about 80% of the workforce in industry as a whole, the machinery and wood processing branches can be mentioned as important branches which are not included in the author's estimation. The workforce weights for the two branches were 11.3% and 5.6% for 1900, 10.5% and 5.8% for 1908, and 10.5% and 5.5% for 1912, respectively. These branches were omitted because long-term production data for them was not available. In other words, it was assumed that the two branches grew at the same rates as industry as a whole.

According to Kafengauz's data, however, the production of 'steam locomotives, railroad cars', a representative product for machinery, grew relatively rapidly ([5, стр.296-297]). More specifically, its average annual growth rate for 1887-1913 amounted to 6.7%, and for 1887-1900, to 15.2%. If the machinery branch is included in the author's estimation, it would be expected that a production index is obtained whose growth rates are slightly higher at least up to the year 1900.

Ⅳ. Estimation results

Ⅳ-1. Branch indices and an index for entire industry

Table 12 shows estimation results of the author's production indices for each industrial branch, whereas Table 13 displays average annual growth rates obtained from these indices. In Table 12 index numbers for the chemical and construction materials branches for some years are not available due to the lack of necessary production data. Let us examine Table 13 in order to see changes in real production for each industrial branch. According to the table, for the three branches of the chemical, fuels and construction materials, average annual growth rates for 1860-1913 greatly exceed the average rate for all branches of 5.1% (this rate will be explained later). The ferrous metals and textile branches also secure more than 5% of growth. As opposed to these branches the growth rate for the food industry falls short of the average, whereas nonferrous metallurgy displays quite a low rate of growth. If we divide the entire estimation period into two, that is 1860-1888 and 1888-1913, most branches accelerated their growth in the latter half. Especially for the 1890s, which is known as a high growth period for the Russian economy, an average annual growth rate for industry as a whole amounts to 8.5% in the estimation (for the years, 1890-1900; see Tables 16 and 17). Particularly remarkable is the growth of the ferrous metallurgy, for which was responsible the well known industrialization policy based on railroad construction under the guidance of Finance minister Sergei Witte. It is also worth noting that

Table 12 Production index for each industrial branch in Tsarist Russia: 1860–1913 (1900 = 100)

	Fuels	Fer. met.	Nonf. met.	Chemical	Con. mat.	Textile	Food
1860	1.4	9.4	62.1	2.0	–	13.6	29.3
1861	1.8	8.7	60.7	–	–	12.7	29.3
1862	1.7	7.5	60.7	–	–	4.1	29.6
1863	1.7	8.5	60.8	–	–	5.2	27.8
1864	1.9	8.7	58.4	–	–	7.8	30.9
1865	1.8	8.5	64.5	2.6	–	7.6	28.4
1866	2.1	8.6	68.0	–	–	14.1	25.7
1867	2.1	8.3	67.2	–	–	15.8	36.5
1868	2.2	10.1	69.7	–	–	12.3	33.3
1869	2.9	11.0	81.0	3.5	–	15.4	33.4
1870	3.3	11.6	87.2	3.6	–	13.4	35.6
1871	4.0	11.7	94.5	2.1	–	20.0	34.3
1872	5.2	12.3	98.0	–	–	17.3	36.2
1873	5.7	11.7	80.0	–	–	16.9	39.4
1874	6.3	13.3	79.9	–	–	22.4	38.5
1875	8.3	13.9	79.2	6.2	–	25.0	38.4
1876	9.1	13.9	81.8	–	–	22.6	37.6
1877	9.1	13.2	98.1	6.4	–	21.3	40.2
1878	12.7	14.8	100.1	6.2	–	34.4	39.6
1879	14.8	20.0	101.6	4.6	–	30.9	46.7
1880	16.4	23.6	102.1	11.8	–	27.6	46.2
1881	18.2	23.7	88.2	8.9	–	43.5	44.8
1882	20.0	21.7	86.7	10.9	–	37.2	53.9
1883	21.4	20.9	84.7	13.3	–	42.9	53.9
1884	22.6	21.3	89.4	–	–	35.4	56.3
1885	25.4	21.1	81.6	20.9	–	36.3	59.6
1886	26.8	22.6	82.1	–	–	40.2	69.0
1887	27.9	22.7	85.7	30.0	–	54.0	63.4
1888	32.8	22.5	85.9	31.5	–	40.1	63.6
1889	38.3	26.5	90.4	46.5	–	50.0	67.6
1890	38.8	33.0	96.7	47.9	32.5	39.9	64.2
1891	41.9	35.2	95.5	47.4	–	44.2	65.0
1892	45.8	39.4	104.3	49.1	–	47.8	64.8
1893	51.2	43.6	108.7	54.9	29.8	54.3	67.0
1894	54.9	47.4	104.5	61.7	–	58.6	85.9
1895	61.6	51.9	101.1	66.3	77.2	65.8	87.1
1896	62.6	59.7	92.9	70.5	–	79.1	99.6
1897	69.8	67.6	96.7	76.7	118.1	79.2	106.4
1898	78.7	80.1	98.4	79.6	–	82.3	98.4
1899	86.4	91.3	99.3	83.7	–	93.2	102.5
1900	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1901	107.8	96.1	101.0	117.2	–	103.7	106.6
1902	104.9	89.0	93.2	118.3	–	112.1	116.6
1903	104.3	89.9	94.0	120.0	–	115.7	121.4
1904	111.3	103.1	93.5	119.5	–	117.3	124.1
1905	89.5	87.0	89.7	119.8	97.3	110.4	124.5
1906	100.2	89.7	99.1	130.5	–	115.7	128.9
1907	112.7	95.2	106.1	133.9	–	124.8	150.3
1908	113.1	95.9	120.2	145.8	95.8	131.0	143.9
1909	118.6	103.8	137.3	150.2	–	132.0	149.8
1910	117.6	111.2	154.9	168.2	127.1	137.2	141.0
1911	119.6	129.3	155.7	179.6	151.1	136.0	167.0

1912	125.4	149.7	157.1	189.5	171.3	156.6	168.1
1913	133.7	163.2	160.4	196.6	217.1	179.4	161.0

Note: — means "not available". For the estimation method, see the text.

Table 13 Average annual growth rates for each branch (%)

	Fuels	Fer. met.	Nonfer. met.	Chemical	Con. mat.	Textile	Food
1860-1875	12.5	2.6	1.6	8.0	—	4.1	1.8
1875-1888	11.1	3.8	0.6	13.3	—	3.7	4.0
1888-1900	9.7	13.2	1.3	10.1	11.9*	7.9	3.8
1900-1913	2.3	3.8	3.7	5.3	6.1	4.6	3.7
1860-1888	11.9	3.1	1.2	10.4	—	3.9	2.8
1888-1913	5.8	8.2	2.5	7.6	8.6*	6.2	3.8
1860-1913	9.0	5.5	1.8	9.1	—	5.0	3.3

Note: — means "not available". Calculated from Table 12. Growth rates for the construction materials branch with the mark (*) refer to 1890-1900 and 1890-1913.

Table 14 Estimates by the author of production indices for Tsarist Russian industry (total industry): 1860–1913

	1887 workforce weight	1890 workforce weight	1900 workforce weight	1908 workforce weight	1912 workforce weight	Link index
1860	12.4	11.9	9.4	8.9	8.5	12.4
1861	11.9	11.5	9.3	8.9	8.5	11.9
1862	8.5	8.1	6.4	6.1	5.7	8.5
1863	9.0	8.6	6.8	6.5	6.1	9.0
1864	10.4	9.9	8.0	7.6	7.3	10.3
1865	10.2	9.9	7.9	7.5	7.2	10.2
1866	13.6	13.2	11.0	10.5	10.1	13.6
1867	15.4	14.9	12.3	11.9	11.3	15.3
1868	13.7	13.3	10.8	10.3	9.9	13.7
1869	15.9	15.4	12.8	12.3	11.8	15.8
1870	15.4	14.9	12.4	11.9	11.4	15.4
1871	18.2	17.7	15.0	14.5	14.1	18.2
1872	17.9	17.5	15.1	14.7	14.2	17.9
1873	17.7	17.2	15.2	14.8	14.3	17.7
1874	20.7	20.2	17.8	17.5	16.9	20.6
1875	22.5	22.0	20.0	19.7	19.2	22.4
1876	21.6	21.2	19.4	19.1	18.6	21.6
1877	21.8	21.3	19.4	19.1	18.5	21.8
1878	27.1	26.7	25.1	25.1	24.6	27.1
1879	28.8	28.3	26.2	26.0	25.4	28.8
1880	29.7	29.3	27.1	26.8	26.2	29.7
1881	35.7	35.2	33.4	33.3	32.8	35.6
1882	34.2	33.7	32.1	32.2	31.4	34.1
1883	36.5	36.1	34.8	35.0	34.3	36.5
1884	34.1	33.7	32.5	32.6	31.8	34.1
1885	35.4	35.0	34.3	34.6	33.6	35.4
1886	39.0	38.6	37.7	38.1	37.0	38.9
1887	43.9	43.6	43.2	43.8	42.9	43.8

	1887 workforce weight	1890 workforce weight	1900 workforce weight	1908 workforce weight	1912 workforce weight	Link index
1888	39.0	38.7	38.7	39.2	38.2	38.9
1889	45.9	45.7	46.0	46.7	45.6	45.9
1890	44.3	44.1	43.4	43.5	42.6	44.3
1891	47.0	46.8	46.2	46.4	45.5	47.0
1892	50.2	50.1	49.4	49.5	48.8	50.3
1893	54.3	54.1	53.3	53.7	52.6	54.4
1894	61.4	61.2	60.5	60.9	59.7	61.5
1895	68.5	68.3	68.7	68.8	68.3	68.7
1896	78.1	77.9	77.9	78.2	77.5	77.9
1897	83.8	83.5	83.8	83.7	83.4	83.8
1898	86.2	86.0	85.6	85.4	85.2	85.6
1899	95.0	94.8	94.3	94.1	94.0	94.3
1900	100.0	100.0	100.0	100.0	100.0	100.0
1901	103.0	103.1	104.1	104.6	104.4	104.1
1902	106.3	106.4	107.9	108.9	108.3	107.9
1903	109.2	109.2	110.6	111.7	110.9	110.6
1904	113.5	113.4	114.4	115.3	114.7	114.4
1905	105.8	105.7	105.8	106.6	105.4	105.8
1906	111.2	111.1	111.9	112.9	111.8	112.0
1907	121.8	121.5	122.8	124.3	122.6	123.3
1908	123.5	123.4	124.2	125.5	123.9	124.6
1909	130.7	130.5	131.1	131.8	130.6	130.8
1910	135.3	135.3	135.1	135.2	134.5	134.1
1911	146.9	146.6	145.0	144.4	143.4	143.0
1912	161.3	161.1	158.9	157.9	157.6	157.1
1913	174.9	174.9	173.6	172.2	173.3	172.8
Average annual growth rate(%)	5.12	5.20	5.66	5.76	5.86	5.10

Note: For the estimation method, see the text.

Table 15 Differences in indices for total industry due to the differences of the indication method for branch indices

Indication method for branch index		Average annual growth rate of index for total industry (%)	
		Arithmetic average	Geometric average
Fixed reference year	1860=100*	5.33	4.60
	1900=100	4.11	4.65
	1913=100	4.03	4.61
Shifting reference year	every 5 years	**5.10**	4.69
	every 10 years	5.02	4.69
	every 15 years	5.08	4.69
	every 20 years	5.11	4.65
	every 25 years	5.20	4.66
	every 30 years	5.46	4.69

Note: *) Calculated excluding the construction materials branch. The final index for entire industry in this paper is, as stated in the text, the index which is derived by averaging branch indices (which are expressed in the form of shifting the reference year every five years) based on an arithmetic mean (indicated in Gothic type in the table above).

the textile and food industries, which occupied some 30% and 15% respectively of the whole of Russian industry in terms of labour force, steadily increased their production even in the latter half of the estimation period. It was in Soviet times that growth rates for these light industries slowed down.

As stated above, while most branches increased their growth tempos in the latter half of the period, the fuels branch decreased its growth in that period. The decline for the fuels branch relates to the fact that the oil production at Baku oilfields gradually reached its peak and began to stagnate or even decline at the beginning of the twentieth century (see Table A-1). In the same token growth rates for the ferrous metallurgy showed a remarkable decline in the first decade of the twentieth century.

Table 14 displays five index series for entire industry, which are derived by averaging branch indices shown in Table 12 by means of an arithmetic mean with labour force weights for 1887, 1890, 1900, 1908 and 1912, and also a final index linking the five series based on the rule stated in Table 8. On calculation, index numbers of branch indices were indicated in the form of shifting the reference year every five years, as explained in Ⅲ-4. The five series demonstrate a tendency to grow faster when the base year is more recent, which could be explained as a result of a gradual increase in workforce shares for branches whose growth rates were relatively high.

As has been previously discussed, when a production index for entire industry is calculated, various results are obtained depending on how branch indices are expressed. Table 15 summarizes results derived from several conceivable ways of making calculations. First let us look at the cases in which an arithmetic mean is used when branch indices are averaged. In the case of a fixed reference year, the further back it is set, the higher are growth rates yielded by a resulting index for total industry, as explained earlier using Table 5. As shown in Table 15, for example, the total index obtained as averaged branch indices whose index numbers are put at 100 in the year 1860 shows a relatively high growth rate of 5.33%. On the other hand, the average annual growth rate of the link index based on branch indices whose values for 1900 are given as 100 is a rather low rate of 4.11%, and is only 4.03% in the case where the reference year is fixed at 1913. In table 15 the construction materials branch is excluded in the calculation of the final index with the reference year of 1860, because a production index for this branch is not available for this year. Since the expansion for the construction materials branch is assumed to be faster than the average, the growth rate for the final index with the reference year of 1860 would be higher than 5.33%, if this branch could be included in the calculations.

It is expected from the arguments in Ⅲ-4 that in shifting the reference year, the shorter the interval of shifting, the lower the growth rate of the resulting index. The results shown in Table 15, however, do not exhibit such a tendency. In fact the growth rate of the final index based on the scheme of shifting the reference year every five years, as employed in this paper, is higher than for those when a shift is made every ten or fifteen years. This result could be explained by the fact that the production for entire industry decreased in several shorter periods of time in the overall estimation period. In this case values of an index get smaller when reference years are divided more narrowly.

Table 15 also shows the cases in which a geometric mean is employed. Since the resulting indices are identical in every case, growth rates are also identical. In this paper, however, the value in 1860 for the construction materials branch is not available, so weights for six branches excluding the construction materials branch are used for 1860, and weights for seven branches are employed for 1913. Due to this adjustment, growth rates of the total indices somewhat vary depending on the form of expression for branch indices. But differences among the indices are negligible, and in most cases growth rates are the same.

Ⅳ−2. Comparison with other indices

Table 16 Comparison of production indices for Tsarist Russia's industry (total industry): 1860–1913 (the year 1900=100)

	Suhara arith. mean (1)	Suhara arith. mean (2)	Suhara geo. Mean	Kondra tieff arith. mean	Kondra tieff geo. mean	Goldsmith imputed	Goldsmith unad-justed	Nutter	Kafen-gauz (1)	Kafen-gauz (2)
1860	12.4	20.2	14.9	15.2	8.2	14.0	15.9	9.6		
1861	11.9	20.1	14.3	14.4	7.9	13.5	15.5			
1862	8.5	16.5	8.9	10.4	5.1	10.8	13.9			
1863	9.0	16.7	9.9	11.4	6.0	11.6	14.0			
1864	10.3	18.4	12.0	12.1	7.1	12.0	14.2			
1865	10.2	17.8	11.8	11.9	6.5	11.9	14.5	7.2		
1866	13.6	20.4	14.9	16.2	8.8	15.6	18.0			
1867	15.3	23.7	16.9	16.7	9.5	15.9	18.3			
1868	13.7	22.1	15.7	15.7	9.6	15.4	17.9			
1869	15.8	24.1	17.8	18.5	10.8	17.4	20.4			
1870	15.4	24.6	17.6	18.1	10.8	17.3	20.6	10.8		

	Suhara arith. mean (1)	Suhara arith. mean (2)	Suhara geo. Mean	Kondra tieff arith. mean	Kondra tieff geo. mean	Goldsmith imputed	Goldsmith unad-justed	Nutter	Kafen-gauz (1)	Kafen-gauz (2)
1871	18.2	27.5	20.3	21.2	12.1	19.7	23.0			
1872	17.9	28.1	20.3	20.9	12.5	19.5	23.0			
1873	17.7	26.9	20.0	20.2	13.3	18.9	22.0			
1874	20.6	29.2	23.0	23.0	15.4	21.2	23.9			
1875	22.4	29.6	24.6	24.5	17.3	22.2	24.7	16.7		
1876	21.6	29.5	23.6	24.2	17.7	22.3	25.2			
1877	21.8	30.3	23.7	23.8	17.1	22.3	25.9			
1878	27.1	35.8	29.4	31.5	22.5	27.7	30.9			
1879	28.8	37.5	31.3	32.0	24.6	28.9	32.3			
1880	29.7	37.1	31.9	31.9	25.2	29.1	32.7	22.6		
1881	35.6	41.6	37.1	39.1	31.4	34.6	36.6			
1882	34.1	40.9	36.2	37.4	30.4	33.6	36.4			
1883	36.5	42.9	38.1	40.5	32.7	36.7	38.9			
1884	34.1	41.9	36.2	38.1	32.0	35.2	36.8			
1885	35.4	41.8	37.2	39.0	33.7	37.6	40.0	32.3		
1886	38.9	46.7	41.0	39.3	34.7	38.9	41.1			
1887	43.8	50.5	45.6	46.4	39.7	44.0	45.5		33.1	31.8
1888	38.9	45.4	40.8	41.9	37.1	41.6	43.9	38.4	36.6	36.2
1889	45.9	52.1	47.9	48.3	43.8	46.4	48.3		40.2	39.2
1890	44.3	48.4	45.8	48.0	44.7	50.7	52.2	41.9	40.4	39.7
1891	47.0	51.8	48.5	50.6	48.0	53.4	55.0		42.8	42.8
1892	50.3	55.0	51.8	53.5	51.0	55.7	57.3		46.2	45.9
1893	54.4	57.9	55.7	60.8	57.8	63.3	64.9		51.7	52.3
1894	61.5	66.6	63.2	61.4	59.4	63.3	64.6		55.2	56.1
1895	68.7	71.0	69.8	67.3	64.5	70.4	71.9	65.8	59.3	60.5
1896	77.9	79.5	78.9	70.8	68.7	72.9	73.5		69.0	66.9
1897	83.8	86.2	84.8	76.5	75.1	77.8	78.6		71.6	73.0
1898	85.6	86.0	86.5	83.6	82.3	85.5	85.8		77.4	79.8
1899	94.3	94.1	94.8	92.8	91.4	95.4	95.5		89.7	90.9
1900	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1901	104.1	104.1	104.1	101.0	100.1	103.2	103.3		100.0	102.2
1902	107.9	107.9	107.5	102.0	100.9	108.7	104.0		99.7	105.0
1903	110.6	110.6	110.0	105.4	104.5	105.7	106.2		103.9	109.9
1904	114.4	114.4	114.1	110.2	109.7	109.2	109.3		112.0	116.0
1905	105.8	105.8	104.9	102.2	101.5	97.2	98.4	101.9	108.3	108.0
1906	112.0	112.5	111.1	111.6	109.9	109.6	111.6		113.7	111.8
1907	123.3	124.1	122.2	117.7	116.1	114.9	118.0		123.8	121.8
1908	124.6	124.5	123.3	120.4	119.7	117.6	120.2		124.5	122.8
1909	130.8	131.1	129.5	124.0	122.3	121.2	124.5		128.6	128.0
1910	134.1	133.1	132.5	140.8	137.4	137.0	138.1	131.6	133.4	139.2
1911	143.0	141.7	140.8	150.2	146.2	144.4	144.5		148.7	152.8
1912	157.1	155.4	154.6	156.0	152.6	149.8	149.1		161.8	167.3
1913	172.8	170.6	169.2	168.2	163.8	158.5	157.2	168.4	177.1	175.3

Note: Index numbers of "Suhara arithmetic mean (1)" are transferred from the final (link) index in Table 14. "Suhara arithmetic average (2)" is the final index base on the arithmetic mean calculated from the seven branch series whose index numbers for 1900 are set at 100. This index is the index "fixed reference year: 1900=100: arithmetic average" in Table 15. "Suhara geometric mean" is the final index based on the geometric mean calculated from the seven branch indices expressed in the same way as those of "Suhara arithmetic mean (1)". This index is the index "shifting reference year:

every five years: geometric average" in Table 15. "Kondratieff" and "Goldsmith" are quoted from [20, pp.462-463]. As is stated in Section Ⅱ, the original Kondratieff index was extended back to 1860 by Goldsmith. There are some misgivings about the accuracy of figures in the Kondratieff index with an arithmetic mean calculated by Goldsmith, as pointed out in footnote 5) of this paper. In addition the Goldsmith index has a problem indicated in the footnote 11). If this point is taken into consideration, the average annual growth rate for the whole period falls by 0.1%. It is supposed that the value of Goldsmith's imputed index for 1902 should be recorded as 103.7, not 108.7 in his original paper. "Nutter" is calculated based on [24, p.345]. "Kafengauz (1)" and "Kafengauz (2)" are calculated based on [5, стр.292-293]. "Kafengauz (1)" is an index based on labour force weights. "Kafengauz (2)" is an index based on gross output value weights. It is supposed that the value of Goldsmith's imputed index for 1902 should be written as 103.7, not 108.7 in his original paper.

Table 17 Comparison of production indices (average annual growth rate, %)

	Suhara arith. mean (1)	Suhara arith. mean (2)	Suhara geo. mean	Kondra tieff arith. mean	Kondra tieff geo. mean	Goldsmith imputed	Goldsmith unad-Justed	Nutter	Kafen-gauz (1)	Kafen-gauz (2)
1860-1875	4.0	2.6	3.4	3.2	5.1	3.1	3.0	3.7		
1875-1888	4.3	3.3	4.0	4.2	6.0	4.9	4.5	6.6		
1888-1900	8.2	6.8	7.7	7.5	8.6	7.6	7.1	8.3	8.7	8.8
1900-1913	4.3	4.2	4.1	4.1	3.9	3.6	3.5	4.1	4.5	4.4
1860-1888	4.2	2.9	3.7	3.7	5.5	4.0	3.7	5.1		
1888-1913	6.1	5.4	5.9	5.7	6.1	5.5	5.2	6.1	6.5	6.5
1860-1913	5.1	4.1	4.7	4.6	5.8	4.7	4.4	5.6		

Note: Calculated from Table 16.

Tables 16 and 17 compare this paper's indices with other estimates. The two tables include the author's three indices: an arithmetic mean obtained by averaging branch indices expressed in the form of shifting the reference year every five years ("Suhara, arithmetic mean (1)"), an arithmetic mean obtained by averaging branch indices with the reference year of 1900 as in Goldsmith ("Suhara, arithmetic mean (2)"), and a geometric mean obtained by averaging branch indices expressed in the same way as "Suhara, arithmetic mean (1)". Figure 1 compares "Suhara, arithmetic mean (1)" with Goldsmith's imputed index.

As Table 17 shows, growth rates calculated from the author's final index ("Suhara, arithmetic mean, (1)") are rather higher than those of the Goldsmith index, and generally the author's growth rates are situated roughly in the middle of the cited estimates. More precisely, the average annual growth rate for the entire estimation period (1860-1913) of the author's index is 5.1%, whereas 4.6%

for the Kondratieff index (arithmetic mean), 5.8% for the Kondratieff index (geometric mean), 4.7%, for the Goldsmith index (imputed), and 5.6% for the Nutter index. For the average growth rate in the latter half of the period (1888-1913), 6.1% is obtained for the author's index, 5.7% for Kondratieff (arithmetic mean), 6.1% for Kondratieff (geometric mean), 5.5% for Goldsmith (imputed), 6.1%% for Nutter, and 6.5% for Kafengauz ("Kafengauz (1)" in Tables 16 and 17 is an index based on labour force weights, whereas "Kafengauz (2) is based on gross output weights). It can be said that the difference between the Goldsmith index and the author's is caused by estimates for the latter half of the period, whereas the difference between Nutter and this index is brought about by estimates for the first half of the period[13].

Discrepancies between the Goldsmith and the author's indices seem to be caused by several factors. The first reason is the difference in sample products. As stated in Ⅲ-2, some 10 products whose growth rates are generally higher than the existing items, were used in addition to those in Goldsmith. This translates into the more rapid growth tempos found in this paper's estimation compared to those in Goldsmith.

The second reason can be the difference in the indication method of individual indices: the reference year of branch indices in the author's estimation was expressed as shifting every five years, whereas in the case of Goldsmith the reference year was fixed at 1900. This fact also seems responsible to explain the higher growth rates of this paper's index. This can be confirmed by a relatively low growth rate of 4.1% for the author's arithmetic-mean-index (2) based on branch indices whose reference year is set at 1900 in the same way as Goldsmith.

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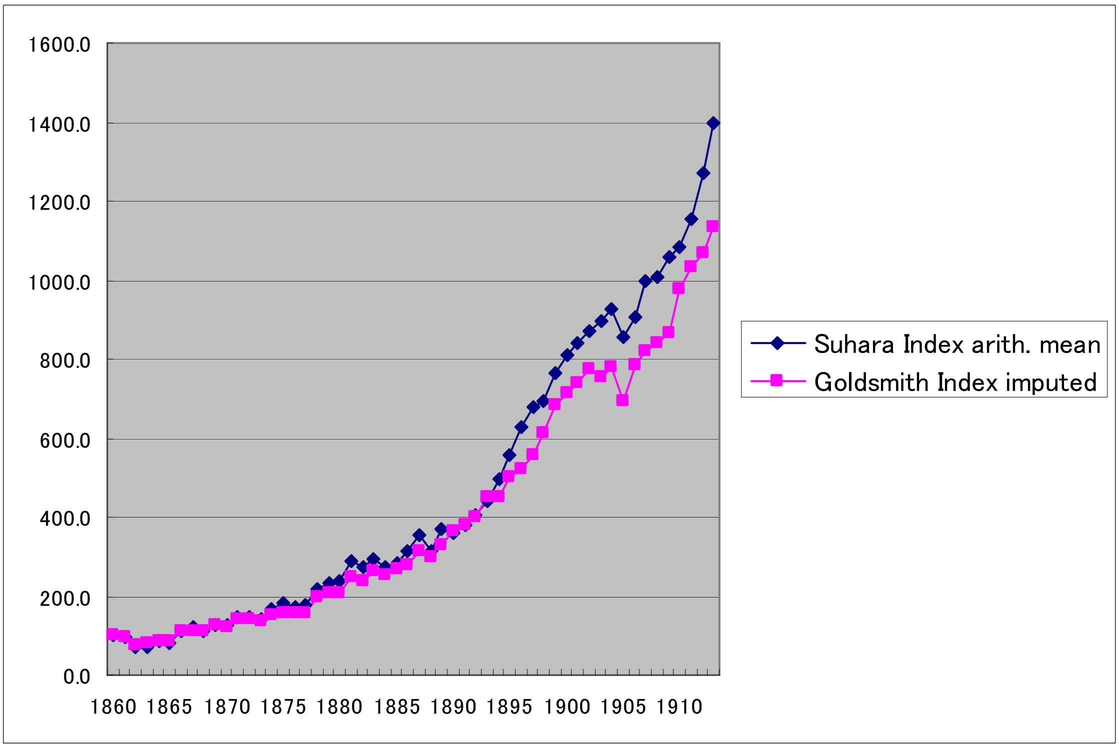
13) The table below shows results of the calculation of average annual growth rates based on the log linear regression using the least square method. The basic characteristics seem to be almost the same as Table 17.

	Suhara arith. mean (1)	Suhara arith. mean (2)	Suhara geo. mean	Kondra tieff arith. mean	Kondra tieff geo. mean	Goldsmith imputed	Goldsmith unad-justed	Nutter	Kafen-gauz (1)	Kafen-gauz (2)
1860-1875	5.4	3.8	5.2	4.8	6.5	4.3	4.0	4.1		
1875-1888	5.2	3.8	4.7	4.8	6.6	5.4	4.6	6.5		
1888-1900	8.1	6.9	7.7	6.9	7.8	7.0	6.6	8.2	8.3	8.6
1900-1913	3.7	3.7	3.5	4.0	3.8	3.4	3.5	4.0	4.2	4.1
1860-1888	5.6	3.9	5.2	5.1	7.2	4.9	4.4	5.9		
1888-1913	5.5	4.9	5.2	5.2	5.4	4.8	4.7	5.7	6.1	5.7
1860-1913	5.5	4.3	5.2	5.1	6.5	5.2	4.8	6.1		

Figure 1　The Suhara and Goldsmith indices (the year 1860=100)



Source: Calculated from Table 16. The Suhara index means "Suhara, arithmetic mean (1)".

The third factor which caused differences between the two estimates seems to be the weight system. Comparing Table 3 and Table 9, for example, we notice that weights given to ferrous metallurgy are quite different for the two series. Since growth rates for this branch are considerably high especially in the latter half of the estimation period, smaller weights assigned to this branch in the author's estimation must make the growth rates lower than those of Goldsmith. Unfortunately, this issue cannot be clarified due to the lack of details regarding weight for his index.

Goldsmith, recalculating on the basis of an arithmetic mean the original Kondratieff index, which was based on a geometric mean, showed a new index whose growth rate is lower than the original one (the new index is displayed in Tables 16 and 17 as "Kondratieff arithmetic mean"). Growth rates generated from an arithmetic mean index are lower than those from a geometric mean index, only because the reference year of individual indices is fixed at a year which is relatively late in the overall estimation period, as already stated in this paper. In fact in the author's indices growth rates of an arithmetic mean index (1) are greater than those of a geometric mean index (2).

According to the Gerschenkron effect, the Nutter index must show rather low growth tempos, because the base year of the index is set at 1913, the last year of the estimation period. But, in fact, his estimate indicates relatively high growth rates, as is shown in Tables 17[14]. To explain this seemingly odd result, he suggested that the Tsarist government had granted more and more tariff protection to industries which were growing rapidly in that period [22, pp.344-345]. However, another likely reason is that he employed commodities whose output expanded relatively rapidly compared to sample items of the Kondratieff-Goldsmith estimates. Also it seems that he obtained a production index which expanded more rapidly than the author's because he did not incorporate in his calculations some products whose growth rates were relatively low, such as gold and flour.

Kafengauz's estimates show the highest rates of expansion for Russian industry among cited estimations. As Paul Gregory [4, стр.483] pointed out, this can be explained by the fact that growth tempos of individual products are generally high because his data on their output is based on the territory of the Soviet Union as of the end of the 1920s.

If the estimation in this paper were to be accepted as the most valid, the growth rate for Russian industry should be slightly raised especially for or after the 1890s. This could mean that the reinforcement of government involvement in the economy should be more highly evaluated. This is because the second-half of the estimation period could be characterized by the intensification of the state participation in the economy, such as the industrialization policy by Sergei Witte and other government leaders[15].

Ⅴ. Some problems with the estimation——in place of conclusions

There are some difficult problems in this paper's estimation. In this section these points are given in place of conclusions. Firstly, there is an issue with the base year of the index, although this is a problem common to all the cited estimations in this paper. Despite the fact that the estimation period is the years

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14) In Nutter's estimation price and value added are employed as weight. The former is used as weight for products which were produced consistently within industry from raw materials to finished goods, whereas the latter is employed for products whose materials were produced in other sectors of the economy, such as agriculture. Out of 26 sample products 10 items belong to the latter.
15) For this type of discussion, see, for example, Bovykin (В. И. Бовыкин) [2].

1860-1913, the oldest base year of weight in the author's calculation is 1890 for price, and 1887 for workforce. While this is a result of restrictions on the availability of data, it is obviously desirable to employ the oldest weights possible. We should strive to discover new data on weight.

Secondly, in the author's estimation price is used as weight instead of value added. The latter may be more desirable here, but to collect systematic data on it is difficult, as stated above. Related to this issue is also a question about the difference in productivity among industrial branches. In fact labour productivity is thought to have varied considerably between large-scale and middle- or small-scale production. While the fuels, ferrous and nonferrous metals and chemical branches can have fallen under the former, the latter occupied the greater part of production in the light industries such as textiles and food. The labour productivity in the former was probably much higher than in the latter. If we accept the assumption that there is a tendency for the level of labour productivity to correspond to the size of value added per worker, it means that there is a possibility of unjustifiably high weights being attached to the light industries in this paper's estimation. An additional problem is that primary data on workforce at that time has no clear distinction made between workers inside and outside the establishments especially for branches where the "putting-out system" was prevailing. This could also lead to a possible overestimation for light industries. As shown above, growth rates for these industries are relatively low, and hence it is possible that the author's index underestimates growth of industry as a whole.

Thirdly, the reliability of this paper's index for the first half of the estimation period is likely to be substantially lower than the latter half. To begin with, the trustworthiness of factory statistics in this period is poorer than the subsequent years[16]. Moreover, the number of sample products is limited and physical output data is not available for a lot of years within this period. Due to the lack of data, the author's total industry index is calculated on the basis of indices for only five industrial branches (excluding the chemical and construction

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[16] According to Shoichi Tomioka, the mid-1890s can be regarded as an epoch when the quality of industrial statistics substantially improved, although the improvement might not be fully satisfactory [27, Ch. 4, Sc. 1]). In fact, while administrative and police organizations had taken charge of collection and inspection of factory reports until then, factory inspectors and machinery engineers of prefecture and state newly came to participate in the duties from this period on. In addition the investigation items were increased in number and clarified in substance. Tomioka, however, points out the limitations of the reforms.

materials branches) for many years before 1887. For the years after 1888 the total index is compiled based on six or seven branch indices. What is more, for the years before 1887 the number of output data taken into account is fewer than for the latter half. As shown in Table 6 above, while the author's calculations for the second half period cover 31 commodities, only 20 items are included for the first half.

Fourthly, the estimation in this paper does not contain any products for the machinery or wood processing branches. The lack of data for the machinery branch in particular suggests a possibility of underestimation for growth. As is well-known, the Russian economy in the late 19th century was characterized by the rapid development of the network of railroads[17]. The Russian government actively promoted domestic production of railroad-related goods such as rails and locomotives, especially after the introduction by Finance minister Vyshnegradskii of the 1891 tariff act, which was extremely protectionist. Under these circumstances the production of ferrous metallurgy showed a remarkable growth in the 1890s, as exhibited in Tables 12 or 13 above or the data on physical output of 'steam locomotives, railroad cars' quoted in Ⅲ-7. The judgment seems valid that the lack of the machinery sector can have caused a downward bias in the author's index at least for the late 19th century.[18].

Lastly, there is another problem, which was touched on earlier in this paper: the author's index, in the same way as other cited estimates, refers only to mining and the factory industry. In fact manual industry (town handicraft (*remeslo*) and country handicraft (*kustarnichestvo*)) was also an important part of the Tsarist Russia's industry. Goldsmith gave attention to this issue and, assuming that a total disregard of handicraft induces an upward bias, made a downward revision of his growth rate by 0.5-1% ([20, pp.468-469]). The grounds for this revision were S. G. Strumilin's estimation that the growth rate of small-scale industry (remeslo and kustarnichestvo) from 1887 to 1913 was 3.75% and that the production ratio of small-scale industry to factory industry was about one third (More exactly, the ratio gradually declined from

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17) Paul Gregory, for example, states that "the most impressive relative improvement between 1861 and 1913 was the development of a rail network that was the largest on the European continent by 1913 ··· and was comparable on a per capita basis to countries like Italy and Austria-Hungary." ([21, p.159]).

18) Gerschenkron commented on the Kondratieff index, which (like the author's) does not include products of the machinery sector, that " the index does not include machinery production, an omission which in view of the relative smallness of the industry before 1914 cannnot have led to a serious distortion of the index."([19, p.145]). From 1900 onwards, however, more than 10% of total

about a half in older days to about one fifth at the beginning of the 20^{th} century (С. Г. Струмилин, *Очерки советской экономики: ресурсы и перспективы*, 1928). The author has little information to add to that, but would like to point out that the following figures are cited in V. I. Vainshtein's book. According to Vainshtein, Pokrovskii (В. И. Покровский, *К вопросу об устойчивости активного баланса русской внешней торговли*, 1901) calculated "national income" of small-scale industry in 1894 at 600 million rubles, and that of total industry including mining and manufacturing at 1 billion 852.8 million rubles ([3, стр.54]). Also Prokopovich (С. Н. Прокопович, *Опыт исчисления народного дохода 50 Европейской России в 1900-1913 гг.*, 1918) is said to have estimated 337.9 million rubles for remeslo, 235 million rubles for kustarnichestvo, and 1 billion 421 million rubles for total industry in European Russia in 1900, and 611.6 million rubles for remeslo, 289.9 rubles for kustarnichestvo, and 2 billion 566.6 million rubles for total industry in 1913 [3, стр. 62]). Small-scale industry as computed based on figures of Pokrovskii, accounts for 32.4% of total industry, while based on the figures of Prokopovich, it occupies 38.6% in 1900 and 35.1% in 1913. These results roughly confirm the estimation by Goldsmith. In any case, the author's estimate must also be revised downward to take small-scale industry into consideration. Thus the index in this paper has several problems to be tackled. Further effort is needed for the overall improvement of the estimations.

labour force was engaged in machinery production, as stated above.

【Appendix Ⅰ：Physical output of industrial products in Tsarist Russia】

Table A-1 Physical output of industrial products

	Fuels		Ferrous metals				Nonferrous metals			
	Crude oil (mill. tons)	Coal (mill. tons)	Pig iron (th. tons)	Iron (th. tons)	Steel (th. tons)	Rails (th. tons)	Copper (th. tons)	Lead (th. tons)	Zinc (th. tons)	Gold (tons)
1860	0.004	0.30	335	210	1.6	10.7	5.20	1.09	1.84	24.4
1861	0.004	0.38	319	194	1.9	5.7	4.93	0.81	2.54	23.8
1862	0.004	0.35	250	172	2.0		4.75	0.88	2.58	23.9
1863	0.01	0.36	279	197	2.0	12.3	4.82	1.17	2.47	23.9
1864	0.01	0.40	300	182	3.5	22.6	4.51	1.35	2.94	22.9
1865	0.01	0.38	299	176	3.9	23.1	4.15	1.63	3.09	25.8
1866	0.01	0.45	304	186	4.3	14.2	4.42	1.71	3.14	27.2
1867	0.02	0.44	288	188	6.3	7.1	4.24	1.74	2.95	27.0
1868	0.03	0.45	324	223	9.6	23.6	4.39	1.64	3.25	28.0
1869	0.04	0.60	329	236	7.6	42.3	4.26	1.07	3.63	33.2
1870	0.03	0.69	360	249	8.8	40.7	5.05	1.65	3.78	35.4
1871	0.03	0.83	359	256	7.2	38.5	4.52	1.77	2.73	39.3
1872	0.03	1.09	399	268	9.2	30.5	3.72	1.22	3.03	41.4
1873	0.07	1.17	385	256	8.9	26.3	3.66	0.94	3.38	33.2
1874	0.09	1.29	380	299	8.6	48.9	3.27	1.34	4.13	33.2
1875	0.13	1.70	427	304	12.9	43.8	3.65	1.08	3.99	32.7
1876	0.19	1.82	442	293	17.9	43.9	3.87	1.17	4.62	33.6
1877	0.25	1.79	400	267	44.3	41.7	3.50	1.20	4.73	41.2
1878	0.33	2.52	417	274	64.2	72.4	3.52	1.40	4.65	42.1
1879	0.40	2.92	433	280	210	154	3.12	1.36	4.32	43.1
1880	0.35	3.29	448	292	307	203	3.20	1.15	4.39	43.3
1881	0.66	3.49	469	292	293	207	3.46	0.99	4.55	36.8
1882	0.83	3.78	463	297	248	163	3.59	0.57	4.47	36.1
1883	0.99	3.98	483	323	222	117	4.36	0.54	3.67	34.9
1884	1.48	3.93	510	362	207	92.0	6.22	0.63	4.32	35.7
1885	1.91	4.27	504	362	193	94.7	4.72	0.71	4.59	33.0
1886	1.90	4.58	516	363	242	113	4.57	0.78	4.20	33.4
1887	2.36	4.53	598	369	226	87.9	4.99	0.99	3.62	34.9
1888	3.01	5.19	647	365	222	64.3	4.60	0.80	3.87	35.2
1889	3.28	6.21	726	428	259	95.7	4.80	0.58	3.69	37.2
1890	3.37	6.01	916	433	378	173	5.73	0.84	3.77	39.4
1891	4.53	6.23	983	448	434	171	5.46	0.56	3.68	39.1
1892	4.69	6.95	1050	497	515	197	5.32	0.88	4.37	43.0
1893	5.53	7.61	1125	499	631	237	5.46	0.84	4.50	44.9
1894	4.92	8.76	1309	503	703	250	5.41	0.74	5.01	42.9
1895	6.75	9.10	1429	440	879	302	5.85	0.41	5.03	41.1
1896	6.80	9.38	1595	498	1022	367	5.83	0.26	6.26	37.2
1897	7.28	11.20	1849	512	1225	399	6.94	0.45	5.88	38.2
1898	8.33	12.31	2216	482	1619	468	7.29	0.24	5.66	38.8
1899	8.96	13.97	2682	520	1897	464	7.53	0.32	6.33	38.9
1900	10.38	16.16	2916	489	2216	496	8.26	0.22	5.96	38.8
1901	11.56	16.53	2837	382	2228	482	8.47	0.16	6.10	39.1
1902	11.08	16.47	2569	311	2184	420	8.82	0.23	8.27	34.9
1903	10.42	17.86	2464	279	2434	338	9.23	0.11	9.89	34.7
1904	10.89	19.61	2954	261	2766	420	9.84	0.09	10.61	33.9
1905	7.56	18.67	2717	160	2266	383	8.51	0.78	7.91	33.5
1906	8.17	21.73	2691	157	2496	300	9.35	1.01	10.09	36.8
1907	8.66	26.00	2822	156	2671	331	13.29	0.50	10.12	37.8

	Crude oil (mill. tons)	Coal (mill. tons)	Pig iron (th. tons)	Iron (th. tons)	Steel (th. tons)	Rails (th. tons)	Copper (th. tons)	Lead (th. tons)	Zinc (th. tons)	Gold (tons)
1908	8.74	25.91	2814	142	2698	361	16.23	0.52	9.96	42.4
1909	9.30	26.82	2872	118	2940	500	18.44	1.06	9.61	48.7
1910	9.63	25.43	3041	55.3	3314	505	22.69	1.31	10.84	53.9
1911	9.18	28.42	3595	44.2	3949	508	26.44	1.24	12.21	52.0
1912	9.29	31.13	4199		4503	624	32.66	1.62	20.32	47.8
1913	9.23	36.05	4636		4918	641	33.10	1.53	19.36	49.2

	Chemicals						Construction materials			Textiles	
	Phosphoric fertilizer (th. tons)	Sulfuric acid (th. tons)	Soda ash (th. tons)	White lead (th. tons)	Zinc oxide (th. tons)	Matches (bill.)	Cement (th. tons)	Bricks (mill.)	Window glass (mill. m^2)	Ginned cotton cons. (th. tons)	Woollen yarn (th. tons)
1860	0	5.1	0	0	0					46.5	
1861			0							43.3	
1862			0							13.9	
1863			0							17.7	
1864			0							26.8	
1865	0	6.5	0.35	0	0					26.0	
1866										48.3	
1867										54.0	
1868										41.9	
1869			1.28							52.5	
1870	0	7.9	1.32	0	0					45.9	
1871			0.77							68.2	
1872										59.0	
1873										57.8	
1874										76.4	
1875	0	15.5	0.63	0	0					85.4	
1876										77.1	
1877			0.56							72.6	
1878			0.54							118	
1879			0.40							106	
1880	0	23.0	0.89							94.1	
1881			0.67							149	
1882			0.81							127	
1883			1.00							147	
1884										121	
1885	0	36.7	5.00							124	
1886										137	
1887			11.1							184	
1888	0.86	43.5	18.0	3.10	1.01	59.3				137	
1889			18.6			139.7				171	
1890	1.36	40.0	20.1	3.05	0.90	142.9	173	833	3.08	136	13.4
1891			19.6		0.84	144.7		764		152	
1892	1.07	36.5	27.7	3.01	0.23	146.6		744		164	
1893	6.94	44.3	46.1	3.58	0.25	137.0	137	760		187	17.9
1894			45.9			157.5				190	
1895	18.7	52.0	47.8	5.77		167.1		1617		201	28.5
1896			58.6			166.7				224	
1897		59.8	61.1	7.95	0.29	182.3		2474		225	
1898						183.2				233	
1899			69.8			186.3				264	

	Phosphoric fertilizer (th. tons)	Sulfuric acid (th. tons)	Soda ash (th. tons)	White lead (th. tons)	Zinc oxide (th. tons)	Matches (bill.)	Cement (th. tons)	Bricks (mill.)	Window glass (mill. m^2)	Ginned cotton cons. (th. tons)	Woollen yarn (th. tons)
1900	48.1	105.7	86.2	8.32		208.8	803	1768	14.3	262	54.9
1901						231.6				264	
1902						233.9				286	
1903						237.3				295	
1904						236.2				299	
1905	80.5	177.7	86.9	8.76		224.1	865	1531	15.8	273	64.9
1906						245.4				296	
1907						251.7				319	
1908			109.1	9.03	2.12	275.5	902	1388	16.8	347	70.2
1909						273.8				349	
1910	112.9	249.7	132.2	12.15	2.85	295.5	1210	1763	23.8	362	73.8
1911	123.3	275.3	148.2	11.25	3.74	306.2	1484	2114	25.3	351	75.4
1912	150.1	283.7	164.2	11.08	3.78	311.2	1757	2341	27.2	421	82.0
1913	115.0	292.2	160.0	18.00		322.5	2131	3090		424	110.2

	Food									
	Raw sugar cons.* (th. tons)	Refined sugar* (th. tons)	Vegetable oil (th. tons)	Flour (th. tons)	Starch & syrup (th. tons)	Crude alcohol* (100%) (th. kl)	Beer (th. kl)	Salt (th. tons)	Cigarettes (bill.)	Makhorka (th. 20kg crates)
1860	57.3					351		430	0.34	
1861	57.3					351		432	0.36	
1862	47.5					351		749	0.41	
1863	35.9					351		507	0.50	
1864	53.0					385		363	0.52	
1865	72.9					314		502	0.51	
1866	55.2					286		647	0.66	
1867	105					386		725	0.71	
1868	123					321		603	0.81	
1869	82.8					370		652	1.07	
1870	105					385		475	1.14	
1871	123					344		457	1.40	
1872	89.6					404		651	1.57	
1873	122					406		756	1.64	
1874	128					386		726	1.86	
1875	132					387		585	2.02	
1876	156					340		684	1.84	
1877	208					326		474	2.50	
1878	174					342		782	2.02	
1879	182					438		818	2.24	
1880	206					402		779	2.24	
1881	203					381		831	2.19	965
1882	261					401		1167	2.43	1305
1883	287					397		1138	2.66	2188
1884	309					413		1024	2.90	2237
1885	343					414		1133	3.13	2112
1886	476					387		1197	3.25	2182
1887	725	281		2.45		367	356	1157	3.34	2184
1888	389	280	60.3	2.43	88	435		1113	3.47	2135

	Raw sugar cons.* (th. tons)	Refined sugar* (th. tons)	Vege-table oil (th. tons)	Flour (th. tons)	Starch & syrup (th. tons)	Crude alcohol* (100%) (th. kl)	Beer (th. kl)	Salt (th. tons)	Ciga-rettes (bill.)	Mak-horka (th. 20kg crates)
1889	465	293				403		1394	3.69	2111
1890	403	302	44.6	2.47	106	387	396	1390	3.74	2093
1891	466	306	47.1	2.37	110	385		1351	3.82	2125
1892	486	311	54.6	2.33	131	336		1459	4.25	1878
1893	400	322	63.3	2.66	133	341	345	1351	4.58	2095
1894	579	359				379		1354	4.98	2062
1895	529	351	81.4	3.89	110	371		1540	5.70	2326
1896	680	367		4.45		393	536	1347	5.93	2277
1897	635	381		5.12	87.4	380	566	1562	6.09	2257
1898	654	429				366	537	1505	5.71	2304
1899	683	445				360	591	1681	7.70	2340
1900	794	471	126.7	3.71	89.4	413	587	1968	8.62	2484
1901	807	506				425	574	1706	9.67	2623
1902	959	563				385	571	1847	10.76	2372
1903	1053	557				361	668	1659	9.94	2956
1904	1041	574				405	667	1908	11.82	3089
1905	854	612	195.2	4.86	100	419	729	1844	11.77	2984
1906	872	641				453	880	1790	15.05	3225
1907	1279	677				486	930	1872	14.36	3098
1908	1257	673	236.5	5.25	107	523	876	1847	14.60	3537
1909	1129	710		5.55		560	925	2243	20.39	3626
1910	1033	812	226.6	4.86	131	524	1020	2051	16.73	3698
1911	1882	801	252.1	5.35	131	607	1099	2011	19.84	3699
1912	1848	852	262.3	5.39	131	547	1067	1858	22.53	4262
1913	1235	935	325.0		125	606	1161	1981	25.89	4390

Note: A blank means 'not available'. Output of products with the mark (*) (Raw sugar consumption, Refined sugar and Crude alcohol) means output in a financial year (September in the previous year to August in the current year), not in a calendar year.

Source: [Crude oil] 1860-1862: [8, стр.208]; 1863-1913: [22, p.411]. [Coal] 1860-1913: [22, p.412]. [Pig iron] 1860-1875: [5-1, стр.24]; 1876-1884: [7, стр.Ⅷ]; 1885-1913: [17, стр.452-454]. [Iron] 1860-1877: [5-1, стр.24]; 1878-1886: [9-1, стр.XXXXⅢ]; 1887-1890: [9-2, стр.LⅢ]; 1891-1900: [9-3, стр.XXⅡ]; 1901-1905: [9-4, стр.XXI]; 1906-1911: [9-6, стр.XXI]. [Steel] 1860-1913: [22, p.411]. [Rails] 1860-1895: [5-2, стр.121]; 1896-1913: [22, p.413]. [copper] 1860-1913: [22, p.411]. [Lead] 1860-1913: [22, p.411]. [Zinc] 1860-1913: [22, p.411]. [Gold] 1860-1913: [17, стр.455]. [Phosphoric fertilizer] 1860-1913: [22, p.412]. [Sulfuric acid] 1860-1913: [22, p.412]. [Soda ash] 1860-1913: [22, p.412]. [White lead] 1860-1913: [22, p.413]; for 1905, interpolated, and for 1908, estimated by the author. See AppendixⅡ(3.4.4). [Zinc oxide] 1860-1913: [22, p.412]; for 1908, estimated by the author. See Appendix Ⅱ (3.4.4). [Matches] 1888: [6, стр.19]; 1889-1890: [13-1, стр.615]; 1891-1900: [13-2, стр.446]; 1901-1905: [13-3, стр.274]; 1906-1913: [13-5, частьⅡ, стр.41]. [Cement] 1890: estimated by the author. See AppendixⅡ(1.5.1); 1893-1913: [22, p.413]. [Bricks] 1890-1913: [22, p.413]. [Window glass] 1890: estimated by the author. See AppendixⅡ(1.5.3); 1900-1912, [22, p.413].

[Ginned cotton consumption] 1860-1913: [22, p.414]. [Woollen yarn] 1890: [10-1, стр.360]; 1893-1913: [22, p.415]. [Raw sugar consumption] 1860-1913: [22, p.415]. [Refined sugar] 1887-1898: [13-1, стр.356-357, 393]; 1899-1908: [13-3, стр.158, 163]; 1909-1913: [13-4, стр.20,24]. [Vegetable oil] 1888-1913: [22, p.414]. [Flour] 1887, 1896, [10-1, стр.VI-VII]; 1908: [1-2, стр.212-213]; 1888-1912: [22, p.414]. [Starch and syrup] 1888-1913: [22, p.415]. [Crude alcohol] 1860-1913: [22, p.414]. [Beer] 1887, 1890, 1893: [10-2, стр.VIII-IX]; 1896-1913: [22, p.415]. [Salt 1860-1913: [22, p.414]. [Cigarettes] 1860-1913: [22, p.415]. [Makhorka] 1893-1913: [22, p.415].

【Appendix Ⅱ: Prices for industrial products in Tsarist Russia】

Ⅰ. Prices in the year 1890

(A) The Fuels branch

(1.1.1) Crude oil (нефть): 1.83 rubles /ton. According to the source [10-2, стр.ⅩⅦ-ⅩⅧ], the value of output and the output of crude oil in 1890 were 7,303,000 rubles and 243,442,000 puds, respectively. By dividing the value of output by the output, the price of 3.00 kopeikas per pud is obtained. By converting this price at the rate of 1 pud = 16.38 kg, the above-mentioned price is obtained. While the output of crude oil shown in [10-2, стр.ⅩⅦ-ⅩⅧ] is larger than the output employed in the author's estimation (see Appendix, Table A-1), here the original figure in [10-2, стр.ⅩⅦ-ⅩⅧ] is employed. In case different values for one product are obtained in two or more sources, hereafter the value in the source from which data on the value of output are taken is employed. Although another price for crude oil can be obtained from, for example, price statistics on commodity markets ([11]), prices on commodity markets are generally thought to be higher than production prices because the former includes transportation costs and so on. Prices on commodity markets therefore are not directly employed in the derivation of prices here exactly as they are.

(1.1.2) Coal (каменный уголь): 3.05 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [10-2, стр.ⅩⅦ-ⅩⅧ].

(B) The Ferrous Metals branch

(1.2.1) Pig iron (чугун): 42.7 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [10-2, стр.ⅩⅦ-ⅩⅧ].

(1.2.2) Iron (железо): 97.7 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [10-2, стр.ⅩⅦ-ⅩⅧ].

(1.2.3) Steel (сталь): 73.4 rubles /ton. The price is derived by multiplying the price for rails in 1890 (1.2.4) by the ratio of the price for steel in 1900 (2.2.3) to the price for rails in 1900 (2.2.4).

(1.2.4) Rails (рельсы): 98.1 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [10-1, стр.397].

(C) The Nonferrous Metals branch

(1.3.1) Copper (медь): 739.2 rubles /ton. The prices for a type of copper (иностранная штыковая) on the commodity market in St Petersburg were 14.10 rubles per pud in 1890 and 16.36 rubles in 1900. By multiplying the ratio between the two prices on the commodity market by the price for copper in 1900 (2.3.1), the above- mentioned price is derived. For the data on the prices on the commodity market, see [11-3, стр. V].

(1.3.2) Lead (свинец): 145.5 rubles /ton. The prices for a type of lead (в слитках обыкновенный) on the commodity market in St Petersburg were 2.36 rubles per pud in 1890 and 2.93 rubles in 1900. By multiplying the ratio between the two prices on the commodity market by the price for lead in 1900 (2.3.2), the above-mentioned price is derived. For the data on the prices on the commodity market, see [11-3, стр. V].

(1.3.3) Zinc (цинк): 258.8 rubles /ton. The prices for a type of zinc (силезский) on the commodity market in St Petersburg were 4.84 rubles per pud in 1890 and 4.17 rubles in 1900. By multiplying the ratio between the two prices on the commodity market by the price for lead in 1900 (2.3.3), the above-mentioned price is derived. For the data on the prices on the commodity markets, see [11-3, стр. V].

(1.3.4) Gold (золото): 1160.0 rubles /kg. For the source, see [10-2, стр. XVI].

(D) The Chemicals branch

(1.4.1.1) Phosphoric fertilizer (фосфатные удобрения): 12.2 rubles /ton. The price for ground natural phosphate (фосфоритная мука, 1.4.1.2) is substituted for the price for phosphoric fertilizer, since the latter is not available. The price is derived by dividing the value of output by the output. For the data on the value of output and the output, see [10-1, стр.378].

(1.4.2) Sulfuric acid (серная кислота): 49.2 rubles /ton. The price is derived by dividing the value of output by the output. The output here refers to the sum total of the output in 15 prefectures in Russia where sulfuric acid was produced. Although in 1890 sulfuric acid was produced in 17 prefectures, for 2 prefectures the data on the output is not available in [10-1]. These 2 prefectures therefore are omitted in the calculation. For the source of the data on the value of output and the output, see [10-1, стр.376]].

(1.4.3) Soda ash (кальцинированная сода): 55.0 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [10-1, стр.377].

(1.4.4) White lead (свинцовые белила): 216.4 rubles /ton. The price is derived by dividing the value of output by the output. The output here refers to the sum total of the output in 8 prefectures in Russia where white lead was produced. Although in 1890 white lead was produced in 9 prefectures, for 1 prefecture the data on the output is not available in [10-1]. Therefore, this prefecture is omitted in the calculation. For the source of the data on the value of output and the output, see [10-1, стр.379].

(1.4.5) Zinc oxide (цинковые белила): 221.0 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [10-1, стр.379].

(1.4.6) Matches (спички): 41.6 rubles /millions. The price is derived by dividing the value of output by the output. For the source of the value of output, see [10-1, стр.381]. For the output, see Appendix, Table A-1.

(E) The Construction Materials branch

(1.5.1) Cement (цемент): 23.2 rubles /ton. The price is derived by dividing the value of output by the output. The calculation is based on the value of output and the output in those prefectures for which output data in pud are available in [10-1]. To explain the calculation in detail for reference, the sum total of output of cement in 1890 in 9 prefectures, for which output data are available, was 8,359,279 puds + 117,072 bochkas + 71,700 meshoks, whereas the total value of output was 4,010,500 rubles for Russia as a whole. Out of the above-mentioned output the value of output corresponding to the output of 8,359,279 puds was 3,172,000 rubles, which indicates the price for cement in 1890 was 0.38 rubles per pud. By using this price and the total value of output, the output in 1890 is estimated as 10,568,970 puds, namely, 173,120 tons (see Appendix Table A-1, the output of cement in 1890). For the source of the data on the value of output and the output, see [10-1, стр.391].

(1.5.2) Bricks (кирпич): 11.2 rubles /thousands. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [10-1, стр.391].

(1.5.3) Window glass (оконное стекло): 0.80 rubles /m^2. According to the source [10-1], window glass was produced in 1890 in 38 prefectures, but output data were available only for 25 prefectures. The total sum of the output for those prefectures where the output was measured in iashchik (box) was 79,958,000 iashchiks, and the corresponding value of output was 1,235,450 rubles. The above-mentioned price was derived by dividing the value of output by the output. On conversion from iashchik into m^2, the conversion rate of 1 iashchik = 21.00 m^2 was employed, which is derived when the price for 1900 (2.5.3) was calculated. Since the total output value of 2,448,990 rubles meant the production of 146,600 iashchiks, the total output of window glass in 1890 was estimated to be 3,080,000 m^2 (see Appendix, table A-1, the output of window glass in 1890). For the source of the data on the value of output and the output, see [10-1, стр.394-395].

(F) The Textiles branch

(1.6.1) Ginned cotton consumption (потребление хлопка-волокна): 512.7 rubles /ton. The prices per pud for a type of ginned cotton (ферганский (средне-азиатский) из американских семян) on the commodity market in Moscow were 10.45 rubles in 1890 and 12.26 rubles in 1900. By applying the ratio between the two prices to the price for ginned cotton consumption in 1900 (2.6.1), the above-mentioned price is obtained. For the source of the data on the prices on the commodity market, see [11-3, стр.Ⅳ].

(1.6.2) Woollen yarn (шерстяная пряжа): 1862.3 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [10-1, стр.411].

(G) The Food branch

(1.7.1) Raw sugar (сарах-песок): 153.8 rubles /ton. The prices per pud of a type of raw sugar (для местного потребления) on the commodity market in Kiev were 4.74 rubles in 1890 and 4.39 rubles in 1900. By applying the ratio between the two prices to the price for raw sugar in 1900 (2.7.1), the above-mentioned price is obtained. For the source of the data on the prices on the commodity market, see [11-3, стр.Ⅶ].

(1.7.2) Refined sugar (сахар-рафинад): 256.4 rubles /ton. The prices per pud of a type of refined sugar (головной местных заводов) on the commodity market in Kiev were 5.91 rubles in 1890 and 5.84 rubles in 1900. By applying the ratio between the two prices to the price for refined sugar in 1900 (2.7.2), the above-mentioned price is obtained. For the source of the data on the prices on the commodity market, see [11-3, стр.Ⅶ].

(1.7.3) Vegetable oil (растительное масло): 226.8 rubles /ton. The price is the average of 4 types of vegetable oil (подсолнечное, льняное, коноплянное, кокосовое) weighted by their outputs. The price of each type of vegetable oil is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [10-1, стр.406-407].

(1.7.4) Flour (мука): 65.4 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [10-1, стр.404].

(1.7.5) Starch and syrup (крахмал и патока): 32.5 rubles /ton. The average price of three types of products (corn starch, other starch, and syrup) weighted by their outputs. The price of each type of starch and syrup is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [10-1, стр.408-409].

(1.7.6) Crude alcohol (спирт-сырец): 122.0 rubles /kiloliter. According to the source [10-2, стр.Ⅷ], the price for crude alcohol (40%) was 60 kopeikas per vedro. By converting this price into the price per kiloliter and per 100% crude alcohol, the above-mentioned price is obtained. The conversion ratio is 1 vedro = 12.3 liters.

(1.7.8) Salt (соль): 6.91 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [10-1, стр.411].

Ⅱ. Prices in the year 1900

(A) The Fuels branch

(2.1.1) Crude oil: 9.58 rubles /ton. The price is derived by dividing the total value of output for the oil-extracting industry in the year 1900 by the output in the same year. For the source of the data on the total value of output, see [1-1, стр.97]. For the source of the output, see Appendix, Table A-1.

(2.1.2) Coal: 3.94 rubles /ton. The price is derived by dividing the total value of output for the coal industry in the year 1900 by the output in the same year. For the source of the data on the total value of output, see [1-1, стр.96]. For the source of the output, see Appendix, Table A-1.

(B) The Ferrous Metals branch

(2.2.1) Pig iron: 33.5 rubles /ton. According to [9-3, стр.288-317], the total output of pig iron in the year 1900 was 179,107,648 puds, and the number of the factories where pig iron was produced was 182. Out of these factories the number of the factories whose output value is available is 92. By dividing the total value of output in the 92 factories (31,814,752.92 rubles) by the total output there (58,027,792 puds), the above- mentioned price is obtained.

(2.2.2) Iron：90.5 rubles /ton. According to [9-3, стр.318-339], the total output of iron in the year 1900 was 29,857,712 puds, and the number of the factories where iron was produced was 139. Out of these factories the number of the factories whose output value is available is 72. By dividing the total value of output in the 72 factories (25,602,322 rubles) by the total output there (17,275,669 puds), the above-mentioned price is obtained.

(2.2.3) Steel：66.2 rubles /ton. According to [9-3, стр.340-363], the total output of steel in the year 1900 was 135,282,908 puds, and the number of the factories where steel was produced was 83. Out of these factories the number of the factories whose output value is available is 41. By dividing the total value of output in the 41 factories (64,344,784 rubles) by the total output there (59,356,166 puds), the above-mentioned price is obtained. To put prices for steel per pud by region for reference, while the average price for Russia as a whole was 1.08 rubles, the price in Ural region was 0.81 rubles, a relatively low price. In the north-western and the south and south-western regions, the prices were relatively high, 1.12 rubles and 1.10 rubles, respectively.

(2.2.4) Rails：88.5 rubles /ton. In the source [9-3, стр.340-363] prices for rails are mentioned in places as “sales price on the spot”. The prices range from 129 to 145 kopeikas per pud. Taking into consideration the fact that these prices refer to products in Ural region, where prices were relatively low, the author estimates the average price for Russia as a whole as 145 kopeikas per pud. By converting this price into per ton, the above-mentioned price is obtained.

(C) The Nonferrous Metals branch

(2.3.1) Copper：857.7 rubles /ton. The prices for a type of copper (иностранная штыковая) on the commodity market in St Petersburg were 16.36 rubles per pud in 1900 and 15.23 rubles in 1908. By multiplying the ratio between the two prices on the commodity market by the price for copper in 1908 (3.3.1), the above- mentioned price is derived. For the data on the prices on the commodity market, see [11-3, стр. Ⅴ].

(2.3.2) Lead：177.6 rubles/ton. The prices for a type of lead (в слитках обыкновенный) on the commodity market in St Petersburg were 2.93 rubles per pud in 1900 and 3.06 rubles in 1908. By multiplying the ratio between the two prices on the commodity market by the price for lead in 1908 (see later, (3.3.2)), the above-mentioned price is derived. For the data on the prices, see [11-3, стр.Ⅴ].

(2.3.3) Zinc：222.9 rubles /ton. The prices for a type of zinc (силезский) on the commodity market in St Petersburg were 4.17 rubles per pud in 1900 and 4.32 rubles in 1908. By multiplying the ratio between the two prices on the commodity market by the price for lead in 1908 (3.3.3), the above-mentioned price is derived. For the data on the prices on the commodity market, see [11-3, стр.Ⅴ].

(2.3.4) Gold：1236.0 rubles/kg. The price is derived by dividing the total value of output for the gold and platinum-extracting branch in the year 1900 by the output in the same year. While the total value of output, therefore, includes those for platinum as well as for gold, the former was ignored as minor. For the source of the data on the total value of output, see [1-1, стр.96]. For the source of the output, see Appendix, Table A-1.

(D) The Chemicals branch

(2.4.1.1) Phosphoric fertilizer：9.82 rubles /ton. The price for ground natural phosphate (фосфоритная мука, 2.4.1.2) is substituted for the price for phosphoric fertilizer, since the latter is not available. The price is derived by dividing the value of output by the output. For the data on the value of output and the output, see [1-1, стр.194-195].

(2.4.2) Sulfuric acid：36.0 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-1, стр.188-189].

(2.4.3) Soda ash：46.2 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-1, стр.188-189].

(2.4.4) White lead：200.8 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-1, стр.188-189].

(2.4.5) Zinc oxide：244.8 rubles /ton. While the average price for zinc oxide on the commodity markets in St Petersburg and Riga in 1900 was 4.93 rubles per pud, the average price for white lead was 4.04 rubles per pud on the same two markets. By applying this price ratio to the price for white lead (2.4.4), the above-mentioned price is obtained. For the source of the data on the prices on the commodity markets, see [11-2, стр.76].

(2.4.6) Matches: 40.7 rubles /millions. The price is derived by dividing the total value of output for the match-producing industry in the year 1900 by the output in the same year. For the source of the data on the total value of output, see [1-1, стр.97]. For the source of the output, see Appendix, Table A-1.

(E) The Construction Materials branch

(2.5.1) Cement: 17.2 rubles/ton. The price is the average of 3 types of cement (романский, портландский, другие сорта) weighted by their outputs. The price of each type of cement is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-1, стр.120-121].

(2.5.2) Bricks: 11.7 rubles /thousands. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-1, стр.120-121]].

(2.5.3) Window glass: 0.42 rubles /m^2. The price is the average of 3 types of plate glass (полубелое, белое и цветное, бемское) weighted by their outputs. The price of each type of plate glass is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-1, стр.118-119]. The total output available from this source is 4,029,900 puds, which can be considered to be 14,300 thousand m^2 in area, as shown in Appendix, Table A-1. This means that the conversion rate is one pud = 3.55 m^2. Also, the above-mentioned source shows data expressed in iashchik as well as in pud. It can be assumed that, on average, one iashichik = 5.92 puds = 21.00m^2.

(F) The Textiles branch

(2.6.1) Ginned cotton consumption: 601.5 rubles/ton. The price is the average of 7 types of cotton (американский, египетский, остиндский, персидский, средне-азиатский, кавказский, другие) weighted by their consumption. The price of each type of cotton is derived by dividing the value of consumption by the volume of consumption. For the source of the data on the values and volumes of consumption, see [1-1, стр.248-249].

(2.6.2) Woollen yarn: 2292.7 rubles /ton. The price is the average of 4 types of woollen yarn (аппаратная, камвольная, бумажная, льняная и др.) weighted by their outputs. The price of each type of woollen yarn is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-1, стр.270-271].

(G) The Food branch

(2.7.1) Raw sugar: 142.4 rubles /ton. While the average price for raw sugar on the commodity markets in Kiev, Moscow and St Petersburg in 1900 was 4.80 rubles per pud, the corresponding price for 1908 was 4.35 rubles. By applying this price ratio to the price for raw sugar in 1908 (3.7.1), the above-mentioned price is obtained. For the source of the data on the prices on the commodity markets, see [11-2, стр.20] and [11-3, стр.28-30].

(2.7.2) Refined sugar: 253.4 rubles /ton. While the average price for refined sugar on the commodity markets in Kiev, Moscow and St Petersburg in 1900 was 5.96 rubles per pud, the corresponding price for 1908 was 5.24 rubles. By applying this price ratio to the price for refined sugar in 1908 (3.7.2), the above-mentioned price is obtained. For the source of the data on the prices on the commodity markets, see [11-2, стр.20] and [11-3, стр.30-32].

(2.7.3) Vegetable oil: 296.0 rubles /ton. The price is the average of 4 types of vegetable oil (подсолнечное, льняное, коноплянное, кокосовое) weighted by their outputs. The price of each type of vegetable oil is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-1, стр.218-219].

(2.7.4) Flour: 67.8 rubles /ton. The price is the average of prices for wheat flour and for rye flour weighted by their outputs. The prices for the two types of flour per pud are 1.22 rubles and 0.71 rubles, respectively. These prices are obtained by dividing the value of output by the output for each product. For the source of the data on the values of output and the outputs, see [1-1, стр.214- 215].

(2.7.5) Starch and syrup: 108.2 rubles /ton. The price is the average of 5 types of starch (пшеничный, ржаной, рисовый, маисовый, картофельный) and one type of syrup weighted by their outputs. The price of each type of starch and syrup is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-1, стр.220-221].

(2.7.6) Crude alcohol: 112.2 rubles /kiloliter. The prices for crude alcohol (40%, сырой хлебный, с посудой) on the commodity market in Khar'kov were 68.5 kopeikas per vedro in 1890, and 63.0 kopeikas in 1900. By applying this price ratio to the price for crude alcohol in 1890 (1.7.6), the above-mentioned price is obtained. For the source of the data on the prices on the commodity market, see [11-3, стр.Ⅲ].

(2.7.7) Beer (пиво): 70.7 rubles /kiloliter. The price for beer including excise in 1900 was

1.073 rubles per vedro. Since this price included 20.4 kopeikas of excise, the price excluding excise was 0.869 rubles. By converting the price excluding excise per vodro into price per kiloliter, the above-mentioned price is obtained. For the source of the data on the price and excise, see [13-2, стр.184].

(2.7.8) Salt: 4.12 rubles /ton. The price is derived by dividing the total value of output for the salt industry in the year 1900 by the output in the same year. For the source of the data on the total value of output, see [1-1, стр.96]. For the source of the output, see Appendix, Table A-1.

Ⅲ. Prices in the year 1908

(A) The Fuels branch

(3.1.1) Crude oil: 13.6 rubles /ton. The price is derived by dividing the total value of output for the oil-extracting industry in the year 1908 by the output in the same year. For the source of the data on the total value of output, see [1-2, стр.106]. For the source of the output, see Appendix, Table A-1.

(3.1.2) Coal: 4.73 rubles /ton. The price is derived by dividing the total value of output for the coal industry in the year 1908 by the output in the same year. For the source of the data on the total value of output, see [1-2, стр.106]. For the source of the output, see Appendix, Table A-1.

(B) The Ferrous Metals branch

(3.2.1) Pig iron: 26.6 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-2, стр.142-143].

(3.2.2) Iron: 93.5 rubles /ton. According to [9-5, стр.350-365], the total output of iron in the year 1908 was 8,667,990 puds, and the number of the factories where iron was produced was 56. Out of these factories the number of the factories whose output value is available is 34. By dividing the total value of output in the 34 factories (10,878,256 rubles) by the total output there (7,104,666 puds), the above-mentioned price is obtained.

(3.2.3) Steel: 58.4 rubles /ton. The price is the average of 5 types of steel (пудлинговая, цементная, бессемеровская, мартеновская, тигельная) weighted by their outputs. The price of each type of steel is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [9-2, стр.142- 143].

(3.2.4) Rails: 61.4 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [9-2, стр.144-145].

(C) The Nonferrous Metals branch

(3.3.1) Copper: 798.4 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [9-2, стр.142-143].

(3.3.2) Lead: 185.5 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [9-2, стр.142-143].

(3.3.3) Zinc: 231.0 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [9-2, стр.142-143].

(3.3.4) Gold: 1460.2 rubles /kg. The price is derived by dividing the total value of output for the gold and platinum-extracting industry in the year 1908 by the output in the same year. While the total value of output, therefore, includes those for platinum as well as for gold, the former was ignored as minor. For the source of the data on the total value of output, see [9-2, стр.107]. For the source of the output, see Appendix, Table A-1.

(D) The Chemicals branch

(3.4.2) Sulfuric acid: 30.3 rubles /ton. The price is the average of 2 types of sulfuric acid (камерная серная кислота, купоросное масло) weighted by their outputs. The price of each type of sulfuric acid is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-2, стр.186-187].

(3.4.3) Soda ash: 76.3 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-2, стр.186-187].

(3.4.4) White lead: 228.9 rubles /ton. The value of output and the output for the sum total of white lead and zinc oxide for the year 1908 are available from the source [1-2, стр.186-187]. In order to obtain individual prices for white lead and zinc oxide, it is assumed that the ratio of the output of white lead to that of zinc oxide in 1908 is the same as in 1910 (for the outputs in 1910, see Appendix, table A-1). This means that the output of white lead in 1908 was 9,030 tons, whereas the output of zinc oxide in 1908, 2,120 tons. The average prices per pud of the two products on the commodity markets in St Petersburg and Riga in 1908 were 4.59 rubles for white lead, and 5.09 rubles for zinc oxide. The above-mentioned price is obtained from the price ratio and the total output of the two products. For the source of the prices on the commodity markets, see [11-3, стр.92].

(3.4.5) Zinc oxide：254.0 rubles /ton. See the derivation method in the preceding item (3.4.4).

(3.4.6) Matches：39.7 rubles /millions. The price is derived by dividing the total value of output for the match-producing industry in the year 1908 by the output in the same year. For the source of the data on the total value of output, see [1-2, стр.82 или 184]. For the source of the output, see Appendix, Table A-1.

(E) The Construction Materials branch

(3.5.1) Cement : 17.8 rubles /ton. The price is the average of 3 types of cement (романский, портландский, другие сорта) weighted by their outputs. The price of each type of cement is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-2, стр.120-121].

(3.5.2) Bricks： 13.0 rubles /thousands. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-2, стр.120-121].

(3.5.3) Window glass：0.51 rubles /m^2. The price is the average of 3 types of plate glass (полубелое, белое и цветное, бемское) weighted by their outputs. The price of each type of plate glass is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-2, стр.118-119]. The output available from this source is 4,737,400 puds, which can be considered to be 16,800 thousand m^2 in area, as shown in Table A-1 in Appendix. This means that the conversion rate is one pud = 3.55 m^2, the same as in 1900.

(F) The Textiles branch

(3.6.1) Ginned cotton consumption：786.3 rubles /ton. Since it is not possible to obtain the price for ginned cotton consumption directly, the ratio of the 1908 price to the 1900 price is utilized. While the average price of two types of cotton fabrics (суровые, пестротканные) in 1900 weighted by their outputs was 21.8 rubles per pud, the corresponding price in 1908 was 28.5 rubles. By applying this price ratio to the 1900 price for ginned cotton consumption (2.6.1), the above-mentioned price is obtained. For the source of the data on the values of output and the outputs for cotton fabrics in 1900, see [1-1, стр.252-253]; for the corresponding data in 1908, see [1-2, стр.254-255].

(3.6.2) Woollen yarn: 2579.8 rubles /ton. The price is the average of 3 types of woolen yarn (аппаратная, камвольная, бумажная и полушерстяная) weighted by their outputs. The price of each type of cement is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-2, стр.270-271].

(G) The Food branch

(3.7.1) Raw sugar: 129.1 rubles /ton. The price is the average of 2 types of raw sugar (белый сахарный песок, желтый сахарный песок) weighted by their outputs. The price of each type of raw sugar is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-2, стр.232-233].

(3.7.2) Refined sugar: 223.0 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-2, стр.232-233].

(3.7.3) Vegetable oil: 263.4 rubles /ton. The price is the average of 4 types of vegetable oil (подсолнечное, льняное, конопляннoе, кокосовое) weighted by their outputs. The price of each type of vegetable oil is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-2, стр.220-221].

(3.7.4) Flour: 98.5 rubles /ton. The price is the average of prices for wheat flour and for rye flour weighted by their outputs. The prices for the two types of flour per pud are 1.72 rubles and 1.15 rubles, respectively. These prices are obtained by dividing the value of output by the output for each product. For the source of the data on the values of output and the outputs, see [1-2, стр.212- 213].

(3.7.5) Starch and syrup: 118.4 rubles /ton. The price is the average of 4 types of starch (пшеничный, рисовый, картофельный, разный) and one type of syrup weighted by their outputs. The price of each type of starch and syrup is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-2, стр.224-225].

(3.7.6) Crude alcohol: 106.8 rubles /kiloliter. The prices for crude alcohol (40%, сырой хлебный, с посудой) on the commodity market in Khar'kov were 63.0 kopeikas per vedro in 1900, and 60.0 kopeikas in 1908. By applying this price ratio to the price for crude alcohol in 1900 (2.7.6), the above-mentioned price is obtained. For the source of the data on the prices on the commodity market, see [11-3, стр.Ⅲ].

(3.7.7) Beer: 72.5 rubles /kiloliter. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-2, стр.232-233].

(3.7.8) Salt: 5.24 rubles /ton. The price is derived by dividing the total value of output for the salt industry in the year 1908 by the output in the same year. For the source of the data on the total value of output, see [1-2, стр.107]. For the source of the output, see Appendix, Table A-1.

(3.7.9) Cigarettes (папиросы): 1.47 rubles /thousands. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-2, стр.236-237].

(3.7.10) Makhorka (махорка): 1.22 rubles /20-kg crates. Since it is not possible to obtain the price for makhorka directly, the ratio of the 1912 price for cigarettes (4.7.9) to the 1912 price for makhorka (4.7.10) is utilized. By applying this price ratio to the 1908 price for cigarettes (3.7.9), the above-mentioned price is obtained.

Ⅳ. Prices in the year 1912

(A) The Fuels branch

(4.1.1) Crude oil: 21.6 rubles /ton. The price is derived by dividing the total value of output for the oil-extracting industry in the year 1912 by the output in the same year. For the source of the data on the total value of output, see [1-3, стр.10-11]. For the source of the output, see Appendix, Table A-1.

(4.1.2) Coal: 5.16 rubles /ton. The price is derived by dividing the total value of output for the coal industry in the year 1912 by the output in the same year. For the source of the data on the total value of output, see [1-3, стр.10-11]. For the source of the output, see Appendix, Table A-1.

(B) The Ferrous Metals branch

(4.2.1) Pig iron: 38.2 rubles /ton. The price is the average of 4 types of pig iron (литейный, передельный, отливка из домен, зеркальный) weighted by their outputs. The price of each type of pig iron is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-3, стр.40-41].

(4.2.2) Iron: 98.8 rubles /ton. According to the source [9-6, стр.ⅩⅩ], the total output for iron in 1911 was 2,967,390 puds. Also according to the same source [9-6, стр.332 -343], the total output of the 26 factories whose data on the production of iron were available was 2,912,788 puds, and the total value of output for iron in these factories was 4,551,559 rubles. By dividing the total value of output by the output, the 1911 price is obtained. The average prices per pud for two types of iron (конвел. сибир., фасонное (балки)) on the commodity market in St Petersburg went up from 1.795 rubles in 1911 to 1.860 rubles in 1912. By applying this climb rate to the 1911 price for iron, the above-mentioned price is obtained. For the source of the data on prices on the commodity market, see [11-4, стр.Ⅴ].

(4.2.3) Steel: 54.2 rubles /ton. The price is the average of 4 types of steel (бессемеровская, мартеновская, томасовская, электросталь) weighted by their outputs. The price of each type of steel is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-3, стр.40-41].

(4.2.4) Rails: 69.2 rubles /ton. The price is the average of 3 types of rails (для гор. кон. и эл. жел. дорог, для пар. ж. дор., рудничные) weighted by their outputs. The price of each type of rails is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-3, стр.42-43].

(C) The Nonferrous Metals branch

(4.3.1) Copper: 877.9 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-3, стр.44-45].

(4.3.2) Lead: 214.6 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-3, стр.46-47].

(4.3.3) Zinc: 284.7 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-3, стр.46-47].

(4.3.4) Gold: 1625.9 rubles /kg. The price is derived by dividing the total value of output for the gold and platinum-extracting industry in the year 1912 by the output in the same year. While the total value of output, therefore, includes those for platinum as well as for gold, the former was ignored as minor. For the source of the data on the total value of output, see [1-3, стр.10-11]. For the source of the output, see Appendix,

Table A-1.

(D) The Chemicals branch

(4.4.1.1) Phosphoric fertilizer: 28.1 rubles /ton. The price for ground natural phosphate (фосфоритная мука, 4.4.1.2) is substituted for the price for phosphoric fertilizer, since the latter is not available. The price is the average for the years 1912-1914. For the source of the data, see [12, стр.6]. Nutter [22, pp.531, 538] estimated the price for phosphoric fertilizer for 1913 (4.4.1.1) as 30.5 rubles /ton, based on different sources.

(4.4.2) Sulfuric acid: 41.9 rubles /ton. The price is the average of 3 types of sulfuric acid (камерная серная кислота, купоросное масло, серная кислота дымящаяся) weighted by their outputs. The price of each type of sulfuric acid is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-3, стр.88-89].

(4.4.3) Soda ash: 49.7 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-3, стр.88-89].

(4.4.4) White lead: 272.7 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-3, стр.102-103].

(4.4.5) Zinc oxide: 304.0 rubles /ton. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-3, стр.102-103].

(4.4.6) Matches: 34.0 rubles /millions. The price is derived by dividing the total value of output for the match-producing industry in the year 1912 by the output in the same year. For the source of the data on the total value of output, see [1-3, стр.10-11 или 108-109]. For the source of the output, see Appendix, Table A-1.

(E) The Construction Materials branch

(4.5.1) Cement: 19.8 rubles /ton. The price is derived by dividing the total value of output for the cement industry in the year 1912 by the output in the same year. For the source of the data on the total value of output, see [1-3, стр.10-11 или 30-31]. For the source of the output, see Appendix, Table A-1.

(4.5.2) Bricks: 15.3 rubles /thousands. The price is the average of 4 types of bricks (строительный, фасонный пустотелый неглазурованный, всякий глазурованный, строительный сырец) weighted by their outputs. The price of each type of bricks is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-3, стр.30-31].

(4.5.3) Window glass：0.40 rubles /m^2. The price is the average of 4 types of plate glass (зеленое и полубелое, белое, бемское, цветное и молочн.) weighted by their outputs. The price of each type of plate glass is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-3, стр.32-33].

(F) The Textiles branch

(4.6.1) Ginned cotton consumption：762.8 rubles /ton. Since it is not possible to obtain the price for ginned cotton consumption directly, the ratio of the 1912 price to the 1900 price is utilized. While the average price of two types of cotton fabrics (суровые, пестротканные) in 1900 weighted by their outputs was 21.8 rubles per pud, the corresponding price in 1912 was 27.6 rubles. By applying this price ratio to the 1900 price for ginned cotton consumption (2.6.1), the above-mentioned price is obtained. For the source of the data on the values of output and the outputs for cotton fabrics in 1900, see [1-1, стр.252-253]; for the corresponding data in 1912, see [1-3, стр.132-133]. If we average prices for six types of ginned cotton for 1913 sated in the source [14, стр.78], we obtain 874.0 rubles. This price, however is that on the commodity markets.

(4.6.2) Woollen yarn：2728.0 rubles /ton. The price is the average of 5 types of woollen yarn (аппаратная, камвольная до № 57, камвольная свыше № 57, крученая и фасонная, полушерстяная) weighted by their outputs. The price of each type of woollen yarn is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-3, стр.138-139].

(G) The Food branch

(4.7.1) Raw sugar：134.3 rubles /ton. The price is the average of 2 types of raw sugar (белый сахарный песок, желтый сахарный песок) weighted by their outputs. The price of each type of raw sugar is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-3, стр.112-113].

(4.7.2) Refined sugar：189.2 rubles /ton. The price is the average of 3 types of refined sugar (рафинад головной, рафинад сортовой, рафинадный брак) weighted by their outputs. The price of each type of refined sugar is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-3, стр.112-113].

(4.7.3) Vegetable oil: 300.9 rubles /ton. The price is the average of 4 types of vegetable oil (подсолнечное, льняное, коноплянное, кокосовое) weighted by their outputs. The price of each type of vegetable oil is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-3, стр.112-115].

(4.7.4) Flour: 94.2 rubles /ton. The price is the average of prices for wheat flour and for rye flour weighted by their outputs. The prices for the two types of flour per pud are 1.65 rubles and 1.13 rubles, respectively. These prices are obtained by dividing the value of output by the output for each product. For the source of the data on the values of output and the outputs, see [1-2, стр.110- 111].

(4.7.5) Starch and syrup: 90.1 rubles /ton. The price is the average of 4 types of starch (пшеничный, рисовый, картофельный, разный) and one type of syrup weighted by their outputs. The price of each type of starch and syrup is derived by dividing the value of output by the output. For the source of the data on the values of output and the outputs, see [1-3, стр.116-117].

(4.7.6) Crude alcohol: 103.6 rubles /kiloliter. According to the source [22, p.539], the price for crude alcohol (100%) for 1913 was 140 rubles per kiloliter. The prices for crude alcohol (40%) on the commodity market were 50.0 kopeikas in 1912, and 67.6 kopeikas in 1913. By applying this price ratio to the price for 1913, the above-mentioned price is obtained. For the source of the data on the prices on the commodity market, see [11-5, стр.28].

(4.7.7) Beer: 73.1 rubles /kiloliter. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-3, стр.116-117].

(4.7.8) Salt: 5.48 rubles /ton. The price is derived by dividing the total value of output for the salt industry in the year 1912 by the output in the same year. For the source of the data on the total value of output, see [1-3, стр.10]. For the source of the output, see Appendix, Table A-1.

(4.7.9) Cigarettes: 1.67 rubles /thousands. The price is derived by dividing the value of output by the output. For the source of the data on the value of output and the output, see [1-3, стр.116-117]. According to the source [12, стр.91], the average price of 6 types of cigarettes (including excise) was 3.9 rubles (for the years 1912-1913).

The ratio of this price including excise to the price excluding excise (1.67 rubles) is utilized in the derivation of the price for makhorka (4.7.10).

(4.7.10) Makhorka: 1.39 rubles /20-kg crates. According to the source [12, стр.91], the average price (including excise) of 4 types of makhorkas was 3.2 rubles (for the years 1912-1913). By applying the above-mentioned ratio (see (4.7.9)) to the price including excise, the above-mentioned price of 1.39 rubles is obtained.

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