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PROVISIONAL INTELLIGENCE REPORT

INDUSTRIAL LABOR PRODUCTIVITY IN THE USSR

CIA HISTORICAL REVIEW PROGRAM
RELEASE AS SANITIZED
1999

CIA/RR PR-68
9 August 1954

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NOTICE

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CONTENTS

Appendixes

Tables

Illustrations

INDUSTRIAL* LABOR PRODUCTIVITY IN THE USSR**

Summary

Increasing the productivity of industrial labor represents one of the major economic objectives of the Soviet government, the Party, and the individual industries. In the postwar period a high level of investment, improved technology, better management, and greater skill on the part of workers have been reflected in striking advances in output per man year in industry. Soviet official indexes show that by 1948 industrial labor productivity had recovered from the effects of World War II. From 1948 to 1950 the Soviet index based on 1940 continued to advance rapidly, moving from 108 to 137 -- an increase of 27 percent in 2 years. The Fifth Five Year Plan (1951-55) projected a further gain by 1955 of 50 percent over 1950. On the basis of reports of attainments for the first 3 years of the Plan period, however, it appears that the original goals will not be met and that the Soviet index of industrial labor productivity in 1955 will increase only about 36 percent over 1950.

There is considerable disagreement as to the exact meaning of Soviet figures on productivity, which may overstate the increases achieved and should be used with reservation in international comparisons. Nevertheless, it is believed that published Soviet figures are useful in giving an approximation of trends in industrial labor productivity in the USSR.

* Industrial in this report refers not only to the manufacturing and extractive sectors but also to transportation, construction, communication, and other activities which support production. In Section I the general index of productivity covers only the manufacturing and extractive sectors, while in Section II construction and rail transport indexes are included.

** The estimates and conclusions contained in this report represent the best judgment of the responsible analyst as of 1 July 1954.

Comparisons among industries indicate that the progress has been uneven. Those industries exhibiting the earliest and most persistent postwar gains included the metals and machinery industries, which were favored both as producers of capital goods and as suppliers of military end items. Progress in the extractive industries and in consumer goods manufactures was slower.

I. Total Trends.

1. Scope and Characteristics of the Data.

Labor productivity is defined in this report as the output of a product per unit of labor input.* No attempt is made to measure separately the effects of changes in capital investment, technology, management, and the skill of labor. This report considers rather the combined effect of these factors of production on labor productivity, together with some comment on their general trends.

A productivity index may be considered to be a fraction, that is, a measure of production divided by a measure of employment. It is therefore affected by all the errors which may occur in either the measure of production or the measure of employment selected. In computing aggregate indexes,** moreover, serious statistical biases may be introduced by the technique used for weighting component parts in order to build up a representative total. This problem is most serious in the case of measures of production, since output is frequently expressed in different units which must be weighted by value or some other common measure before they can be added together. These

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* The labor input unit used throughout, unless otherwise stated, is the man-year, which is treated as synonymous with persons employed. This is not so precise as the use of man-days or man-hours, but labor input in these preferable units could not be calculated from available statistics.

** Aggregate indexes are those which combine the trends of subsectors into a "representative" total trend, for example, combining trends in the production of a number of types of machines into an over-all machinery index or the combination of a number of individual industry indexes into a total industrial measure. Both of these levels of aggregation underlie some of the series presented in this report.

difficulties in computing satisfactory measures of total labor productivity have given rise to extended discussion both by Soviet economists and by the Western economists who attempt to use Soviet statistics. For this reason, this report does not attempt to detail all of the pitfalls for the unwary user of productivity statistics but summarizes the principal criticisms in the methodological appendix (see Appendix A).

Although the reader is warned by the preceding paragraph that productivity measures cannot be interpreted as presenting an exact picture, the trends are so pronounced that useful conclusions may be arrived at even from the crude materials at hand.

The postwar years, with the one prewar year, 1940, to which they can be related, have been selected for analysis partly because differences in the structures of prewar and postwar economies make comparisons deceptive and partly because there are serious technical deficiencies of the materials for measuring aggregate productivity prior to 1940 (see Appendix A). It may be said, however, that evidence on the expansion of physical volume warrants the statement that the prewar period was one of substantial achievement in production and productivity even though a satisfactorily precise aggregate measure cannot be agreed on. Table 1* shows advances in volume of physical productivity per worker from 1928 to 1935, as calculated by Walter Galenson in a RAND report.

Some of the newer industries probably gained even more rapidly in the prewar period. Soviet claims of increases in production of machinery in 1937 yield an estimate of 526 percent of 1928 and in electric power, of 722 percent, which on the basis of available information on employment would suggest rapid increases in productivity.

During the prewar period (1928-40) the Soviet official index of productivity in large-scale industry advanced to 324 percent. As has been indicated, however, this was based on a production index which was subject to such inflationary biases that it is generally discredited.

2. War and Postwar Changes.

Postwar changes in the Soviet system of pricing industrial products and lessening of the relative importance of new products included

* Table 1 follows on p. 4.

Table 1

Indexes of Productivity a/
in Selected Industries in the USSR 1/*
1935

1928=100

Industry	Index
Iron Mining	232
Petroleum	158
Blast Furnaces	209
Steel Mills	154
Cotton Yarn	97
Cotton Cloth	112

in the official index should have eliminated, to a considerable degree, the biases in the prewar production index and should make appraisal of the Soviet claims easier for current years.**

Scarcity of firm data on physical volume of production in postwar years makes it difficult to secure independent checks on the extent to which this inflationary price bias has been eliminated from the official index by comparing it with indexes based on physical volume. Two such efforts at estimating production from physcial volume (weighted in proportion to payrolls) have been made, one by Donald Hodgman and one by CIA/ORR. The methodological appendix discusses the technical problems involved in such comparisons.

Table 2*** compares the Hodgman index and the CIA index of industrial production with the Soviet official index. The second section of the table compares indexes of productivity derived from these production indexes by dividing them by the same index of industrial employment.

It will be noted that throughout the period all of the indexes register substantial increases in production, indicating recovery to

* Footnote references in arabic numerals are to sources listed in Appendix C.

** See Appendix A, Section 2, b.

*** Table 2 follows on p. 5.

Table 2

Indexes of Production, Productivity, and Employment
in the USSR
1940 and 1948-55

Year	Production			Employment a/	Productivity		
	Hodgman b/	CIA c/	Soviet Official		Hodgman	CIA	Soviet Official
1940	100	100	100 d/	100	100	100	100
1948	108	99	117 d/	108	100	92	108
1949	131	117	141 d/	115	116	102	122
1950	150	138	173 d/	126	121	110	137
1951	172	157	201 d/	133	131	118	151
1952	N.A.	177	225 e/	140	N.A.	127	161
1953	N.A.	190	250 e/	146	N.A.	130	171
1954	N.A.	207	273 f/	152	N.A.	136	179
1955	N.A.	224	295 f/	158	N.A.	141	187

a. Employment series from 1949 to 1953 computed by dividing official production series by official productivity series; employment for 1954 and 1955 projected on the assumption of smaller increases in industrial employment in these years than in the period 1950-53.
b. 2/
c. 3/
d. 4/
e. 5/
f. Projected on the assumption that the Fifth Five Year Plan for a 70-percent increase in production would be fulfilled.

the 1940 level by about the beginning of 1948 and a steady rise thereafter. The officially announced increases in production and productivity are consistently above those computed from the ORR and Hodgman estimates, but there is no scientific method of determining which index gives the "truer" picture of industrial expansion.

a. Period of the Fourth Five Year Plan (1946-50).

Since Soviet production and productivity suffered cataclysmic declines during the war except in those defense industries

located safely beyond the area of war damage, it is remarkable that the economy recovered to 1940 levels by 1948. This is a testimony to the ruthlessness of the drive of Stalin to rehabilitate the productive machinery and in part to the willingness of the workers, at least temporarily, to cooperate in spite of the lack of substantial improvement in their level of living.

Statistically the year 1950 is characterized by a rise in the official index of production to 173 percent of the 1940 level and of productivity to 137 percent of the 1940 level (see Table 2). The CIA index indicates a growth of 38 percent in production and 10 percent in productivity.

Comparison of the production increases in various industries from 1940 to 1950 indicating the concentration on heavy industry is given in Table 3.

Table 3

Indexes of Production in Selected Industries in the USSR 6/
1940-50

1940=100

Industry	Index
Fabricated Metals	300
Defense	128
Chemicals	192
Nonferrous Metals	204
Electric Power	189
Manufactured Consumer Goods	120
Food Products	101
Forest Products	88

b. Period of the Fifth Five Year Plan (1951-55).

Continuing the trends of the previous 5 years, the projections for the Fifth Five Year Plan called for a further increase in production of 70 percent and of productivity of 50 percent, with a consequent increase in employment of only 13.3 percent. It was pointed out by ORR at the time 7/ that in view of the substantial increase in the population in the working ages this employment in-

crease could easily be exceeded if the situation required it. During the first 2 years of the period the economy followed the planned rate of expansion closely as production increased 30 percent and productivity 17 percent, an annual average of 14 percent in production and 8 percent in productivity. From 1952 to 1953, however, the trend changed. Production increased only 11 percent, and productivity 6 percent. (See Fig. 1.*) The slackening was due in some measure to the disorganization following the death of Stalin and in part to the beginnings of a deliberate shift from the emphasis on high-productivity industries to the development of low-productivity consumer goods production.

The fact that the rate of increase in productivity slackened more pronouncedly than the rate of increase in production was attributable to the abnormally large increase in employment. Whereas it was originally planned to increase industrial employment by 13.3 percent by 1955, it is estimated that employment exceeded this level by mid-1953. Several factors caused this rapid increase. Among them were the release of large numbers of forced laborers, a somewhat relaxed policy of discharges from the armed services, and probably a retention of larger numbers of women than originally contemplated. For the first part of the year, at least, transfers from farm to industry continued.

On the assumption that the trends initiated in 1953 to implement the "new course" will continue in 1954 and 1955, it is estimated that the goal of a 5-year increase of 70 percent in production will be practically attained. Owing partly to the more than planned increase in employment and partly to development of consumer goods production at an accelerated rate, productivity will not attain the planned goal of 50 percent increase over 1950. Table 2 indicates that, according to Soviet announcements for 1951, 1952, and 1953, productivity increased only 25 percent over 1950 instead of the planned 28 percent. With slower increases in industrial production, productivity increases will lag still further behind the planned rate. The projections of the official production increases divided by the CIA estimated employment increases will result in a 1955 productivity index of 136 percent of 1950 instead of the planned 150 percent, when calculated from the official production index, and of 128 percent when calculated from the CIA production index. (See Table 2 and Fig. 2.**)

* Fig. 1 follows p. 8.

** P. 5, above and following p. 8, respectively.

c. Future Prospects.

When the trends of production and productivity are plotted as in Figure 2, a noticeable flattening out of the rates of increase appears after the sharp rise from 1948 to 1951. This deceleration of the rate of expansion is characteristic of economies after a period of rapid growth when previous gains must be consolidated and digested and when growth has attained such a level that further percentages of increase from the large base are more difficult than gains from a small base.

It would be hazardous to extrapolate this slackening growth trend to 1960 or even to 1957 by mathematical formulae. There is reason to believe, however, that the favorable conditions operating during the Fourth Five Year Plan will not recur, nor does it seem likely that the Soviet people, after a few years of improvement in their level of living, can be "weaned" from the consumer benefits and forced to return to extreme emphasis on heavy industry without morale difficulties which would lower productivity. Thus continued increase in the proportion of workers assigned to the low-productivity industries would be a brake on the rate of expansion of total industrial productivity unless capital investment in low-productivity industries is sharply increased. On the other hand, some previously favorable factors will continue to militate against too rapid a drop in the annual increases in productivity. Among these are expanding programs for technical training at all levels -- on-the-job, vocational high school, and technical university. It is possible also that concentration of "know-how" on the consumer industries will produce improvements in physical plant, technology, and management in this sector comparable to past gains in the heavy industry sector.

On balance, therefore, it would appear reasonable to expect a gradual decline in the rate of improvement in productivity from the present (1953 according to the official index) of about 6 percent per year.

On the basis of some highly speculative reasoning, Galenson has arrived at an estimate (shown in Table 4*) of the relationship between productivity trends in the USSR and in the US.

* Table 4 follows on p. 9.

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Figure 1

SOVIET OFFICIAL INDEXES OF INDUSTRIAL PRODUCTION, PRODUCTIVITY, AND EMPLOYMENT

1940 = 100

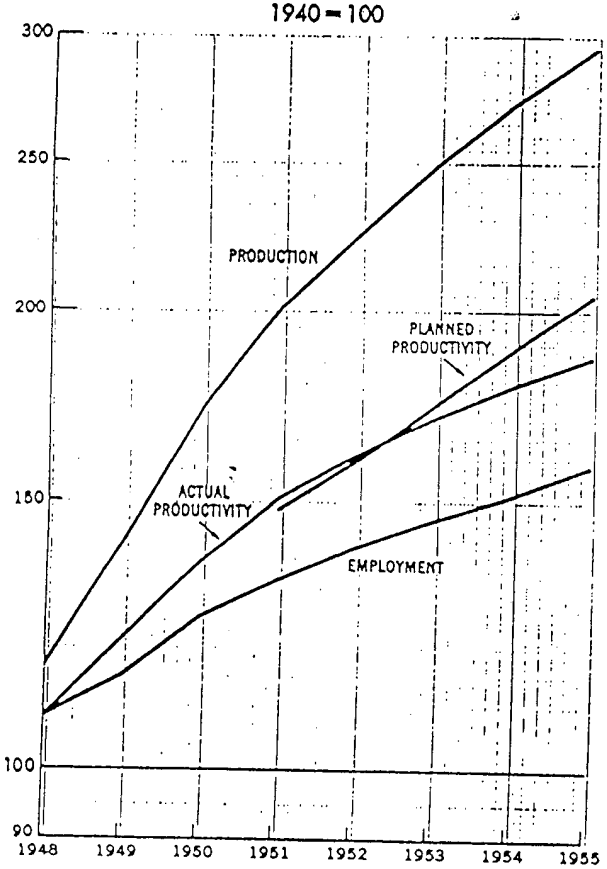
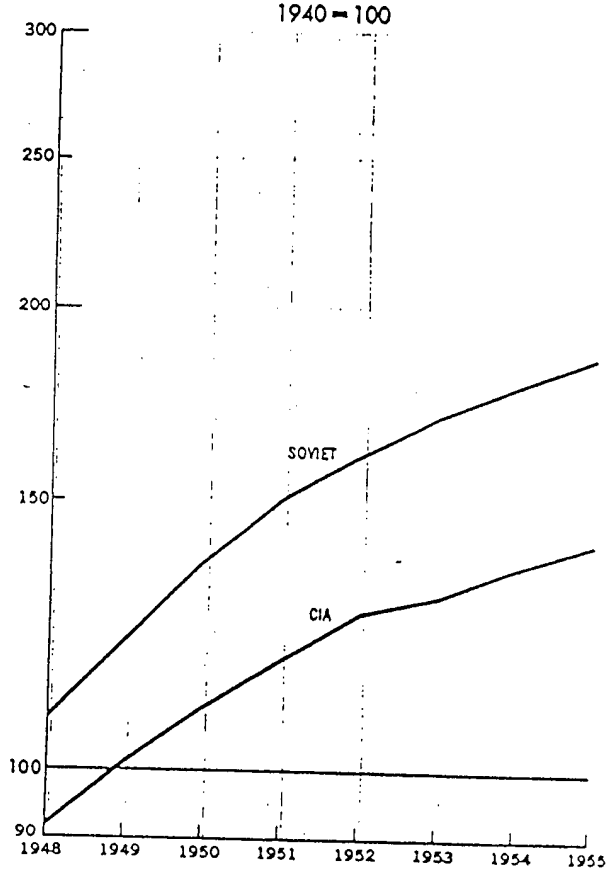


Figure 2

SOVIET OFFICIAL AND CIA INDEXES OF INDUSTRIAL PRODUCTIVITY

1940 = 100



Plotted on semi-logarithmic grid.

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Table 4

Comparison of Productivity of Industrial Labor
in the USSR and in the US
1950 and 1970

US Productivity=100

Assumed Annual Increase (Percent)			
US	Soviet	Soviet Productivity 1950	Soviet Productivity 1970
1.5	3.5	40	59
2.0	3.5	40	54

On Galenson's assumptions, it would appear that Soviet productivity will hardly reach two-thirds of that in the US but that the ratio will gradually become more favorable to the USSR.

3. Factors Affecting Soviet Labor Productivity and Its Measurement.

Some conclusions may be drawn concerning Soviet efforts to increase labor productivity, but the evaluation of the success of their efforts and the impact of the various factors would require detailed analysis beyond the scope of this report.

Doubts have been expressed concerning Soviet claims of productivity increases because of the depressing effects of the destruction which occurred during World War II. However, an analysis of postwar changes in equipment and the utilization of equipment in blast and open hearth furnaces points out that the reconstruction of damaged installations included modernization which would foster the growth of productivity. 8/ It seems more than likely that reconstruction in other industries also entailed modernization. This would facilitate productivity increases, perhaps not always to the level of Soviet claims.

Taken as a crude guide, the increased availability of equipment per worker should contribute to increased output per worker, although the relationship can not be measured. In 1950 the amount of technical

equipment* available per Soviet worker was approximately 53 percent over the 1940 level, and the electrical supply 10/ was 50 percent over the 1940 level. By 1954, electrification per worker had increased an additional 25 percent to 28 percent over 1950. **

With the passage of time, the age and sex structure of the labor force is becoming more normal, with less dependence on lower productivity under- and over-age groups. Soviet emphasis in the post-war period on improved levels of training should also be contributing to increases in output per man as the relatively large numbers of new workers added to the industrial labor force through 1948 use competence they have gained through experience and on-the-job training. 12/ The proportion of personnel with higher and secondary technical training has also increased. By 1950 the number of such personnel had increased by 84 percent over 1940, compared with an increase of 24 percent in total nonagricultural employment. 13/ Through 1955, the former are expected to increase by an additional 70 percent and the latter by approximately 20 percent. 14/ It is also reasonable to suppose that the quality of training has improved.

The impact of these factors varies from industry to industry. It was first felt in those heavy industries where the investments were first made. The impact should be beginning in consumer goods industries, in which new plants have recently begun to operate and labor training plans have been expanded.

The effect of management policies on labor productivity is even less tangible than the other factors. There is, however, no question that Soviet labor control policies are aimed at increasing labor productivity. Although both recurrent agitation for productivity consciousness and incentive provisions are utilized, the effects may be weakened by indifference or other morale factors. Management has also been criticized for failure to utilize available equipment and labor productively. 15/ Increasing emphasis is placed on improved organization of work and the constant-flow method of production as sources of higher labor productivity. 16/ Improvements in transport and communications, and thus in supply, would contribute to productivity increases through elimination of work stoppages and erratic production.

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* The technical equipment index was calculated from the 1955 planned increase over 1940 and 1950. 9/

** Estimated from a speech by Saburov citing an increase of 34 percent over 1949. 11/

The usefulness of Soviet announcements concerning labor productivity has been questioned because it is not known what effect price changes may have had on the indexes. There is also the problem of making adjustments for longer hours worked since 1940, especially in comparison with the earlier periods for which there are concrete output-per-man data on an annual basis. For these and other reasons, the translations of Soviet indexes into absolute physical or monetary terms must be viewed with reserve, in the absence of supporting evidence.

II. Individual Economic Sectors.

This section describes the trends in some of the principal industries and economic sectors. The level of productivity in these categories in 1953 as compared with 1940 (abstracted from the sector sections) is shown in Table 5.

Table 5

Indexes of Labor Productivity in Selected Economic Sectors in the USSR a/*
1953

1940=100

Sector	Index
Manufacturing (Producer Goods)	
Machinery and Instrument Building	256
Iron and Steel	184
Chemicals	175
Extractive	
Petroleum	124
Coal	110 to 112
Peat	109
Iron Ore Mining	100
Timber	96

* Footnote for Table 5 follows on p. 12.

Table 5

Indexes of Labor Productivity in Selected Economic Sectors in the USSR a/
1953
(Continued)

1940=100

Sector	Index
Consumer Goods	
Textiles	117
Services	
Construction	150
Rail Transportation	130

a. Data abstracted from Tables 6-14.

The extent to which the producer goods manufactures have been favored is immediately apparent from this list. This has taken the form of giving these groups highest priority in the assignment of equipment and skilled personnel. The construction and transportation categories also show substantial advances. Next in order in the industrial categories are the consumer goods manufactures. Unfortunately textiles is the only group for which official figures are available, but scattered evidence indicates a similar trend in food processing. With the exception of petroleum extraction the slowest progress is shown by the extractive group.

Analysis of the changes in production goals planned to build up the consumer goods industries indicates that the differential in production will be considerably narrowed by 1955. The effect this will have on productivity will depend on the ratios between capital and labor inputs that are worked out.

1. Coal Industry.

The study of output per man in the Soviet coal mining industry has been relatively easy in the past because of the homogeneity of product and relative availability of data. It is possible to construct several time series for output per worker from official sources. The variations arise largely from the use of employment data referring to different groups -- as to all workers, production workers, or underground workers. 17/

The great need for rehabilitation of mines in the Donets Basin has impeded the recovery of the coal industry in that area. The increased proportion of production now furnished by fields in the eastern regions, where productivity is considerably higher because of the nature of the coal seams and the degree of mechanization, has offset the lower productivity in the Donets Basin. 18/

Increased mechanization also contributed to increasing output per man. By 1949 the cutting and breaking up of coal was 98 percent mechanized; the extraction of coal from the working face, 99 percent; and the loading of coal into freight cars, 98.6 percent mechanized. 19/*

By 1953, output per man per year had surpassed the prewar level by 10 to 12 percent, reaching approximately 351.6 metric tons to 405.2 metric tons. (See Table 6.**)

2. Peat Industry.

Output per man in the Soviet peat industry was scheduled in the Fourth Five Year Plan to reach 192 metric tons per year in 1950; actual output per man in 1950 was 183.5 metric tons, or 103 percent of the 1940 level. 21/ If output per man increased in the years after 1950 at the 1950 rate of 2 percent, 1953 output per man approximated 195 tons. Annual output per worker in the peat industry in the USSR is shown in Table 7.***

* Details on selected mines are given in source 20/.
** Table 6 follows on p. 14.
*** Table 7 follows on p. 14.

Table 6

Annual Output per Worker in Coal Mining in the USSR
1938-53

Year	CIA Estimate (Metric Tons)	Index (1928=100)	Galenson (Metric Tons)	Index (1928=100)
1938	288.0 a/	205.5	326.0 b/	226.3
1939	303.6 a/	216.7	343.6 c/	238.5
1940	312.0 a/	222.6	352.8 c/	244.9
1947	221.0 a/	157.7	257.5 d/	178.7
1948	250.0 a/	178.4	290.9 d/	201.9
1949	272.0 a/	194.1	316.5 d/	219.6
1950	300.0 a/	214.1	345.7 d/	240.0
1951	323.0 a/	230.5	371.9 d/	258.2
1952	335.9 e/	239.7	386.7 d/	268.5
1953	351.6 f/	250.9	405.2 d/	281.3

a. 22/
b. 23/
c. Projected at same rate of increase as CIA estimate.
d. Projected from plan fulfillment announcement. 24/
e. Official plan fulfillment report. 25/
f. 26/

Table 7

Annual Output per Worker in the Peat Industry in the USSR 27/ a/*
1945-53

Year	Metric Tons	Index (1940=100)
1945	100	56.2
1946	122	68.5
1947	140	78.5
1948	150.8	84.7
1949	179.6	100.9

* Footnotes for Table 7 follow on p. 15.

Table 7

Annual Output per Worker in the Peat Industry in the USSR 27/ a/
1945-53
(Continued)

Year	Metric Tons	Index (1940=100)
1950	183.5	103
1951 b/	187.1	105
1952 b/	190.8	107.1
1953 b/	194.6	109.2

a. The data may apply only to Glavtorf of the Ministry of Electric Power Stations.
b. At annual rate of increase of 2 percent.

3. Petroleum Industry.

By 1950, as shown in Table 8,* output per man in the Soviet petroleum industry had regained the prewar level. Assuming no increase in 1940 over the 1938 level of output per man, 28/ the index for 1953 indicates that output per man approximates 904 metric tons of petroleum per year, or 1,484 metric tons of petroleum and gas combined.

Many instances of increases in labor productivity are cited as resulting from improved organization of labor and production. 29/

4. Ferrous Metallurgy Industry.

Plan results indicate that labor productivity in the iron and steel industry exceeded the 1940 level by 31 percent in 1950 and 65 percent in 1953. 30/ Labor productivity in blast and steel furnaces increased at a more rapid rate. 31/ It appears that the index for the industry as a whole was lower because of low rates of increase in productivity in iron ore mining, and perhaps in casting

* Table 8 follows on p. 16.

Table 8

Index of Output per Worker in the Petroleum Industry in the USSR 1949-53

1940=100

Year	Index
1949 a/	95.0
1950 b/	103.6
1951 c/	113.0
1952 d/	118.6
1953 e/	124.5

a. Estimate. 32/
b. Estimate. 33/
c. Estimate. 34/
d. Estimate. 35/
e. Estimated on the basis of the previous year.

and rolling. Changes in labor productivity in the industry are shown in Table 9.

Table 9

Indexes of Output per Worker in the Ferrous Metallurgy Industry in the USSR 1948-53

1940=100

Year	Industry Total	Ore Mining 36/	Pig Iron Smelting	Steel Smelting
1948	106.2 37/			
1949	121.0 38/			
1950	131.0 39/	100		
1951	142.8 40/	100	161 41/	161

Table 9

Indexes of Output per Worker in the Ferrous Metallurgy Industry in the USSR
1948-53
(Continued)

1940=100

Year	Industry Total	Ore Mining 36/	Pig Iron Smelting	Steel Smelting
1952	154.2 42/	100	174 a/	174
1953	164.9 b/	100	184 a/	184

a. Projected at the same rate as all metallurgy.
b. Estimated on basis of previous years.

a. Iron Ore Mining.

In 1937, iron ore output per worker was reported as 904.6 metric tons per year. 43/ The 1940 productivity level of 1,000 metric tons per worker per year may now obtain and may be expected to remain unchanged, even with improved techniques, because of the declining share of open pits in total output. 44/ Increased dependence on the utilization of poor-grade ores will require an increase in concentrating operations, and to that extent lower Soviet productivity in terms of ore ready for use in the blast furnace. 45/

b. Pig Iron Smelting.

For 1937 there are 2 Soviet figures for metric tons per worker per annum, 756 46/ and 801.2 47/, the latter presumably based on the smaller figure of workers directly employed. In 1951 the productivity of labor in blast and steel furnaces was reported to have increased to 161 percent of the 1940 level. 48/ Even assuming no increase in productivity in 1940 over 1937, the 1953 output per worker is indicated as 1,391 metric tons or 1,474 metric tons.*

* 1937 output per man is projected by the index in Table 7.

Contributing to the increase in labor productivity, the utilization of area of blast furnaces had increased in 1950 by 25 percent over 1940. 49/

c. Steel Smelting.

In 1937, output per worker in open-hearth shops was reported as 400 metric tons of steel per annum. 50/ Using the same projection as above, steel smelted per worker in open-hearth shops in 1953 would approximate or exceed 736 metric tons per year.

In open-hearth shops, the utilization of equipment had also increased, so that the removal of steel per square meter of hearth area exceeded the 1940 level in 1950 by 33 percent. 51/

d. Casting and Rolling.

No data were found to bring output per man in casting and rolling up to date. In 1937, rolled output per man was 163 metric tons, and cast iron, 756 metric tons. 52/

5. Timber Industry.

By 1950, labor productivity in the timber industry was scheduled to increase by 54 percent over the 1940 level in logging and by 30.5 percent in manufacturing or to 2,852 rubles and 12,176 rubles per man year, respectively. 53/

In physical terms, output per man in logging in 1953 was 96 percent of the 1940 level in spite of increased mechanization, reportedly as the result of the incorrect utilization of both men and equipment. 54/ In Primorskiy Kray and Sakhalin Oblast, output per registered worker in terms of timber hauled was less than 1 cubic meter per day in 1953. 55/* The average for the whole USSR may have been little higher, judging from the blanket criticism referenced above, and other reports. 56/

In the next 2 or 3 years, output per worker per day is scheduled to be increased to 1.5 to 2 cubic meters in the Far East,

* This relationship measures the total efficiency of the logging unit, in contrast to the measurement of the productivity of workers in each of the activities of a logging unit; that is, felling, skidding, and hauling.

and presumably throughout the USSR. 57/ Achievement of this goal would probably approximate the goal originally set for 1950.

6. Cotton Textiles Industry.

Under the Fourth Five Year Plan, by 1950 the productivity of workers in the textiles industry was scheduled to increase to 127.3 percent of the 1940 level and to 161.8 percent of 1945. 58/ At the same time, the productivity of equipment in various sectors of the textiles industry was to increase by from 14 to 42 percent, bringing output per unit slightly above prewar levels. 59/

It will be seen from Table 10 that, if the estimated rates of increase in labor productivity to 1953 were achieved, the level of

Table 10

Indexes of Output per Worker in the Cotton Textiles Industry in the USSR
1946-53

1940=100

Year	Spinning	Weaving	Combined a/
1946 b/	89.2	67.2	70
1947 b/	82	67.0	70
1948 c/	100	81.0	86
1949 d/	106	94.7	100
1950 e/	110	99.4	105
1951 e/	114	104.0	109
1952 e/	117	109.0	113
1953 e/	120	114.0	117

a. Estimated between spinning and weaving indexes.
b. In view of the data for the previous year, these figures may be erroneous. 60/
c. Interpolated between 1947 and 1949.
d. Estimated from the reported increase in 1949 over 1946 of 19 percent in spinning and 41 percent in weaving. 61/
e. Estimated on the basis of prewar rates of increase. 62/

labor productivity was still below the original 1950 goal. Present annual output per worker in cotton textiles may be as high as 10,000 metric tons.* In spinning a level of 97.2 kilogram-numbers per man per hour may have been attained and in weaving, 12.5 meters per man per hour, depending on the average density of yarn.**

7. Chemicals Industry.

During the Fourth Five Year Plan (1946-50), output per worker in the Soviet chemicals industry was scheduled to increase by 43 percent over the 1940 level. 65/ The 20-percent overfulfillment of the production goal in that period suggests that the productivity goal may have been attained, especially considered in conjunction with the annual rates of increase in productivity in 1950 and subsequent years of 14, 9, and 8 percent. 66/

Sulfuric acid is the only individual product for which both prewar and postwar data on output per worker could be found. The postwar data are for 1945 and pertain to only 2 plants, where output per man appeared to approximate the 1936 level of 314 tons per year. 67/ The reported increase in average daily output of sulfuric acid per cubic meter of tower from 40 kilograms in 1940 to 200 kilograms in 1949 should have contributed to a considerable increase in output per worker. 68/

8. Soviet Metal-Fabricating Industries.

Labor productivity in the Soviet metal-fabricating industries is generally reported to be considerably above prewar levels, which were regained in 1946 and 1947. Although the degree by which the prewar levels are exceeded is almost unquestionably lower in terms of physical units than in terms of value, the complex nature of the production of these industries makes comparison difficult because of the problems of measurement in physical terms.*** Nevertheless, data

* Projected from prewar base. 63/
** Projected from 1940 base. 64/
*** For example, the Molotov construction machinery plant at Dnepropetrovsk reported a 66-percent increase in productivity from 1940 to 1950 in value terms, and a 25-percent increase in physical terms. 69/

showing changes in World War II labor inputs into certain war materials, if accurate, indicate that the percentage increases in productivity cited in the same source were only to a small extent the result of increases in monetary value.* 70/

At any rate, significant advances in productivity in Soviet metal-fabricating industries should have resulted from the priority given them in investment and the higher ratios of equipment to workers than in other industries. The increase in the machine tool pool, with the addition of more productive equipment is also cited by many sources. Some indications are given of increases in labor productivity in individual plants resulting from new equipment and from improved production methods. 72/

As an example of Soviet productivity claims in the field of metal fabricating, the index for the then Ministry of Machine and Instrument Construction is given in Table 11.

Table 11

Index of Labor Productivity in Machine and Instrument Construction in the USSR
1948-53

1940=100

Year	Index
1948 a/	138.0
1949 a/	158.7
1950 a/	188.8
1951 b/	215.2
1952 c/	236.7
1953 d/	255.6

a. 73/
b. 74/
c. 75/
d. Estimated from previous year.

* Voznesenskiy's labor inputs for weapons were compared with US inputs. 71/ The US-USSR ratio of inputs for small arms appeared reasonable, but Soviet artillery inputs were about half those for the US.

The above compares with the original goals for 1950 of 152 percent of 1940 for machine building in general, and 154 percent for machine total building. 76/

a. Antifriction Bearings Industry.

Labor productivity in the Soviet antifriction bearings industry may be estimated from that in State Bearings Plant No. 1, Moscow. As the largest producer, the plant is probably not representative of the industry, but the industry average would be heavily weighted in its direction. Output per worker in Plant No. 1 in 1951 was 268 percent of output per worker in 1946. 77/ If the 1947 level were equal to 1940 productivity, as was generally claimed for machinery industries, the index given in Table 12 would result.

Table 12

Index of Output per Worker in State Bearings Plant No. 1, Moscow a/
1947-51

1940=100

Year	Index
1947	100.0
1948	116.9
1949	127.9
1950	170.7
1951	203.4

a. Data 78/ converted to 1940 base.

If the increases in productivity between 1951 and 1953 paralleled those in Table 11, 1953 would approximate 250 percent of 1940, or about 2,389 units per man-year. 79/

Thus Soviet inputs were assumed to be for assembly time, or for only partially completed weapons. This may not rule out the accuracy of other data that Voznesenskiy used for labor inputs. See p. 23, below.

b. Automotive and Tractor Industry.

Under the Fourth Five Year Plan, labor productivity in the automotive and tractor industry was scheduled to increase to a 1950 level equal to 145 percent of 1940. 80/ It would appear likely that the 1950 goal was attained, if not exceeded, from annual increases planned and apparently approximated of 10 percent in 1947, 17.5 percent in 1948, and 15 to 17 percent in 1949. 81/ Insofar as the level of labor productivity in the automotive industry can be compared to that in the tank industry, the following estimates may be made.

Labor inputs into a T 34 tank in 1941 were reportedly 242 man-hours per ton. 82/ An increase in the automotive and tractor industry to 145 percent of this level would approximate 167 man-hours per ton in 1950. This may be compared with a current estimate derived from analogy to the US of 192 man-hour inputs per ton.*

Productivity in the automotive and tractor industry is scheduled to increase by 50 percent over 1950 in 1955, or to 217 percent of 1940. 84/

c. Transport Machine Building Industry.

Labor productivity in transport machine building was scheduled to reach 200 percent of 1940 in 1950. 85/ This is about 30 percent greater than the rate of increase for machine building as a whole, but in 1936, in value terms, labor productivity in transport machine building industry was only 55 percent of the average of 5 other machine building industries. 86/

The productivity goal for 1950 was probably not achieved. Output per worker in one car-building plant in 1949 was reported as 123 percent of the 1940 level. In the same plant, man-hour inputs into a gondola had been reduced to 580 by the end of 1948. 87/ This may be compared roughly to a current estimated 500-man-hours input into a 2-axle freight car.** As cited by another source, man-hour inputs into

* Estimated from US 1947 equivalents, with Soviet productivity assumed as 66 percent of US productivity and a man-year assumed as 2,000 hours. 83/

** The source 88/ used for this estimate gives man-year inputs which were multiplied by an estimated 2,000 hours per man-year.

locomotives similarly indicate an increase in labor productivity of about 20 percent,* but the inputs cited -- 250,000 hours -- are so high that they must be regarded as erroneous. 89/

d. Oil Machinery Industry.

Labor productivity in oil machinery production reportedly more than doubled in 1949 compared with 1946. 90/ This would tend to indicate that productivity in 1949 was at least 150 percent of that in 1940, and if the 1946 level were equal to 1940, that 1950 was more than 200 percent of the 1940 level. This rate of increase appears possible in the light of increases in productivity in other branches of machine building and the trebling of the production of oil machinery compared to 1940. 91/

9. Railroad Transport.

The productivity of railroad operating personnel in 1950 slightly exceeded the plan goal and, as indicated in Table 13,** increased almost 10 percent over the 1940 level. 92/ Output per operating employee is measured in terms of composite ton-kilometers; that is, of freight, passenger, and baggage movement. In 1949 the unit of measure was changed from operating ton-kilometers to tariff-ton-kilometers.*** 94/ This had a depressing effect on the index.

The railroads in the territories incorporated into the USSR in the west have exerted a continuing downward pull on the national productivity index, but this might be changed by significant increases in traffic volume, since productivity appears to vary with traffic volume.****

* Using the same source which was used to derive the man-hour inputs into 2-axle freight cars, steam locomotives would require about 27,300 man-hours, and electric locomotives, about 39,000 man-hours, if Soviet productivity were 66 percent of US productivity.

** Table 13 follows on p. 25.

*** An operating ton-kilometer is in terms of distance actually covered; a tariff ton-kilometer, the basis of freight charges, is based on the shortest routes possible, given existing track. The effect of this change in the USSR is given in source 93/.

**** For a further discussion, see source 95/.

Table 13

Output per Worker and Index of Output per Worker in Railroad Transport in the USSR 1945-53

Year	Index (1940=100)	Output (Thousand Ton-Kilometers)
1945 96/	75.6	275.4
1946 a/	68.0	248.0
1947 98/	80.0	291.0
1948 99/	91.7	334.0
1949 100/	102.5	374.0
1950 101/	109.8	400.0
1951 b/	116.4	424.0
1952 c/	124.0	452.0
1953 d/	130.0	473.0

a. Calculated from a 61-percent increase during the Fourth Five Year Plan. 97/
b. Interpolated between 1950 and 1952.
c. Calculated on the basis of a 13-percent increase over 1950. 102/
d. Projected at a lower rate (5 percent) than for 1952.

10. Construction.

The index of labor productivity in Soviet construction which can be established from plan fulfillment data, shown in Table 14,* indicates a continued failure to attain plan goals in spite of additional mechanization. 103/ The Fourth Five Year Plan goal for 1950 was 140 percent of 1940 productivity and 172 percent of 1946, as compared with the level achieved in 1950 of 123 percent of 1940. 104/ The increase planned for 1955 over 1950 was 55 percent. 105/ Considering the achievements through 1953, the level attained in 1955 will not be much more than 130 percent of 1950.

* Table 14 follows on p. 26.

Table 14

Index of Output per Worker in Construction
in the USSR
1946-53

Year	Index (1940=100)
1946 a/	81.4
1947 b/	90.3
1948 c/	100.0
1949 c/	111.0
1950 108/	123.0
1951 109/	134.7
1952 110/	144.1
1953 111/	150.8

a. Calculated from index of 1950 over 1940 and over 1946. 106/
b. Calculated on the basis of an 11-percent increase over 1946. 107/
c. Interpolated between 1947 and 1950.

In 1946-47, the output per man-year in construction installation work was about 22,500 rubles. By 1953 it had risen to an estimated 41,400 rubles.*

* One source 112/ gives 13,000 man-days of labor in basic work per million rubles worth of construction and installation work, or 76.9 rubles per man-day. At 283 days per year, calculated from the 1941 Plan, this is 22,500 rubles per man-year. This figure was projected to 1953 by using the index in Table 14. These figures are probably in 1945 rubles, which were being introduced for use in construction estimates at this time. This view is reinforced by the fact that the man-day ruble output calculated from it exceeds 1940 data (in 1926-27 rubles) by 17.2 percent, whereas the index in Table 14 shows 1947 as 90.3 percent of the 1940 level (1940 data were calculated from the 1941 Plan).

APPENDIX A

METHODOLOGY

1. General.

Since labor productivity is a ratio derived by dividing production units by employment units, the significance of the ratio is affected:

a. By any unreliability of the production data or crudity in the statistical procedure adopted for aggregating individual products into combined indexes of production; that is, in aggregating the production of various chemicals into a representative chemical index.

b. By any unreliability of the employment data or any inappropriateness of the employment series for the purpose intended.

2. Measures of Production.

a. Prewar.

It is generally agreed that Soviet published basic data on physical volume of production before 1937 were reliable and published in sufficient detail to constitute the basis of significant measures. Soviet value indexes, however, using 1926-27 ruble prices to calculate total value, gave a grossly exaggerated picture of production increases because they gave inflated values, because new products were artificially "priced in" by procedures which exaggerated their effect, and because they duplicated the value of products which are re-used in fabrication. 113/ This latter problem arises when a basic product is used in producing a finished product, such as when pig iron is fabricated into steel end items. A gross value index would include the value both of the iron and of the fabricated steel, thus duplicating the value of the pig iron.

The difference of prewar productivity indexes based on value from those based on physical volume is shown in Table 15.* 114/

* Table 15 follows on p. 28.

Table 15

Indexes of Production in Selected Industries in the USSR
1934

1928=100

Industry	Indexes	
	Based on Volume	Based on Value
Coal Mining	264	262
Iron Mining	310	359
Petroleum	211	196
Iron and Steel	245	300
Cotton Cloth	104	133
Electric Power	420	622

An additional estimate of the difference between volume indexes and value indexes is furnished by Hodgman 115/ by comparing the Soviet official gross value index with an estimated physical volume index. This shows an advance in the official (value) index from 1934 to 1937 of 80 percent as against only 62 percent in Hodgman's calculated index.

Because of these difficulties which underlie the Soviet official index of production before 1937, no attempt is made in this study to analyze trends before 1940. The major analysis centers on the period 1946-53. The indexes are based on the year 1940 in order to tie the current period to the level attained just prior to World War II. No attempt is made to trace the trends in the abnormal war years from 1940 to 1946.

b. After 1940.

Postwar Soviet official figures relating to the trend in production are probably less exaggerated than prewar series, but there is some controversy as to the extent to which the methodological problems have been eliminated. The indications of improvement are:

In 1936, after widespread criticism of the official series based on gross value in 1926-27 rubles, new pricing procedures were recommended. These were based on new current price schedules, and

the inflation which had been introduced by the previous system of pricing in new products was minimized. It seems probable, however, that the present system of weighting commodities is not strictly based on current prices. Otherwise, the price reductions of recent years would probably have had a depressing effect on the productivity index.

A second effort at improvement has been the tendency to discard the gross value principle in favor of some weighting system based on the net value added. Industry manuals available to CIA, 116/ which contain quite specific instructions as to methods to be employed in the statistical reporting of production, place emphasis on the net value principle.

It should be emphasized that the Soviet production and productivity claims, which are the backbone of this report, are from published figures and that information is lacking as to how the production and productivity reports required by the manuals mentioned above are processed to produce the official published index. In the absence of such knowledge, about all that can be said is that Soviet production figures on which productivity estimates are based provide the only means of attempting to fix the general order of magnitude of the expansion of the Soviet economy.

Since the absence of other data has led all analysts of industrial trends in the USSR to base their conclusions on Soviet production figures, the principal differences in the measures computed arise not from differences in facts as to the volume of production of individual commodities but from methodological differences in the statistical procedures employed to build up aggregate indexes. In order to provide some independent check on the Soviet official index, productivity has been calculated from 2 other production indexes, using the same employment series in all 3 indexes. This comparison, shown in Table 2, brings out the differences between the Soviet official index, Hodgman's index, and the CIA index. The differences shown arise mainly from differences in coverage and differences in statistical method. The two non-Soviet indexes are based insofar as possible on physical production statistics combined insofar as possible with estimated value-added weights. The number of products included is different, and it is apparent that both independent indexes are less comprehensive than the Soviet official index, which is probably based on fairly complete coverage. This comparison is presented not in order to rate one measure or the other measure as superior but to point out the divergence which can arise from different uses of the same data

and to indicate the general agreement in all three as to the existence of a pronounced upward trend even though the steepness of the three curves varies.

Table 2 does not show the differences in the production indexes from which the productivity indexes are derived. This comparison is shown in Table 16.

Table 16

Indexes of Industrial Production in the USSR
Selected Years, 1940-53

1940=100

Year	Hodgman	CIA	Soviet Official
1940	100	100	100
1948	108	99	117
1951	172	158	200
1952	N.A.	174	222
1953	N.A.	190	249

It will be observed that since 1948 there has been substantial agreement between the CIA index and the official index, the former increasing 92 percent and the latter 110 percent from 1948 to 1953.

3. Measurement of Employment.

The employment component of the productivity index is not subject to the same statistical difficulties as the production component. It is highly probable that the employment figures used represent production workers only, the definition being very similar to that of production workers in US statistical usage. For some purposes it would be revealing to have a comparative index based on total employment, thus including the bureaucracy and nonproducers. The tendency to overstaff the nonproductive jobs has at various times led to severe criticism of the system of manpower utilization, and for this reason a measure which would reflect the fluctations in this nonproductive group would give some clue as to waste of manpower. Non-

productive employment cannot, however, be derived from available material, and information on this subject is therefore of an indirect and qualitative nature.

A second unsolved question relates to the type of average which is used for reporting employment. This, however, should not affect the trend of an index unless the definition were changed during the period covered.

A more serious statistical flaw in the productivity measures probably arises from the system of reporting the inputs of slave and prisoner-of-war labor. It appears from the behavior of some of the industry indexes during periods when prisoners of war were being repatriated that the output of this group was included in the production series but that their labor input was excluded.

For the purpose of indexing productivity, a particularly appropriate method is to disregard value and to weight indexes of physical volume by the size of the labor inputs used. This would take the following form for an individual industry:

$$\text{Index of Labor Productivity } (I_{l_p}) = \frac{\text{Output per man in given year } (1)}{\text{Output per man in base year } (0)} =$$

$$\frac{\dfrac{\text{Physical Volume of Production } (1)}{\text{Employment } (1)}}{\dfrac{\text{Physical Volume of Production } (0)}{\text{Employment } (0)}}$$

The aggregate for industries $I' + I'' + I^n$ would then take the form:

$$\text{Aggregate relative} = \frac{I'_{l_p} E' + I''_{l_p} E'' + I^n_{l_p} E^n}{\text{Total Employment}}$$

Such an index has technical advantages as a productivity measure, the principal one being that it is unaffected by changes in the price level. It may be interpreted as follows (to use the simplest case when the number of workers is constant): If the output per worker of 1,000 workers in industry I' increases to 110 percent of the base year and the output per worker of 100 workers in industry I"

increases to 150 percent, then the aggregate productivity of the 1,100 workers increases as follows: $\frac{(110 \times 1{,}000) + (150 \times 100)}{1{,}100} = 114$ percent.

An index of this type was calculated by the Central Statistical Office from 1943 to 1948 117/ except that production may have been expressed in value terms. There is, however, no evidence that it was published. Its abandonment was recommended in 1948, at which time the stated reason was that it did not yield results sufficiently different from the older method to warrant its use. It would appear, however, that an additional reason was that it did not paint a sufficiently optimistic picture of the increase in productivity.

Regardless of whether the Central Statistical Office still uses this principle of aggregation, some of the manuals examined recommend it for the aggregation of products in multiproduct plants, and the planners may base their reasoning as to productivity on such calculations.

APPENDIX B

GAPS IN INTELLIGENCE

Information is lacking as to the components of the Soviet general index of industrial productivity and as to its method of compilation. It is not known whether the Central Statistical Office divides the industrial production index by an employment index or whether it compiles a productivity index directly from plant and ministry reports. It is believed, but not certain, that coverage is industry-wide and not selective.

There is no way of measuring the extent to which production figures are inflated by the inclusion of unfinished or defective material, but scattered evidence indicates that this is a factor. An index would not, of course, be affected by such inclusion if the proportion remained constant. There is reason to believe, however, that the amount of waste in industry in the USSR has been reduced.

The extent of the inclusion of the production of prisoners of war and slave labor is not certain.

Although it is fairly clear that Soviet productivity calculations are based on production workers only, no statistical information is available on nonproduction employees. An index based on the total production and nonproduction employees would be influenced by changes in over-all efficiency and would give valuable information on bureaucratic waste of manpower.

Study should be devoted to the managerial contributions to efficiency.

Specific information is lacking on productivity in food processing, and information is spotty on chemicals. Facts as to productivity in water and road transport are not sufficient to construct an index. Information is lacking on some sectors of metal fabrication, electric power, and communications.

The extent to which the productivity figures announced for industry groups cover all the products of a ministry or only the principal products is not known.