THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

STRUCTURAL DISEQUILIBRIUM, FACTOR PRODUCTIVITY AND SOVIET ECONOMIC GROWTH

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

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Norman, Oklahoma

1974

STRUCTURAL DISEQUILIBRIUM, FACTOR PRODUCTIVITY AND SOVIET ECONOMIC GROWTH

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This study examined the causes and extent of departure from the optimal efficiency frontier in the industrial sector of the Soviet economy. By explicitly accounting for short-falls from the optimal efficiency frontier this study (1) reassessed the relative contributions of capital and labor to economic growth and (2) re-examined the role factor productivity has played in the decline of Soviet economic growth during the 1960's. The purpose of this study was to provide greater insight into the Soviet development model and especially the role of labor and capital in that development. In addition this study overcame the objections to previous studies (e.g. Bergson) by determining factor weights by econometric estimation of industrial production functions rather than using traditional Western weights in calculating total and individual factor productivities. A Constant-Marginal-Share (CMS) production function was used, thereby allowing an explicit measurement of disequilibrium in the factor market, a variable elasticity of substitution of capital for labor over time and the removal of the restrictive assumptions of perfect competition in the factor and output markets.

By identifying the extent of structural disequilibrium in the factor markets, it was found that declines in the rate of growth of inputs and in joint factor productivity are, by themselves, insufficient to explain the lagging growth of Soviet industrial output during the 1960's. It was concluded, therefore, that the inefficient utilization of capital and labor was a significant factor contributing to the decline in Soviet industrial output during the 1960's.

STRUCTURAL DISEQUILIBRIUM, FACTOR PRODUCTIVITY AND SOVIET ECONOMIC GROWTH

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ACKNOWLEDGMENTS

Thanks are due to the members and staff of the Russian Research Center, Harvard University, where the research on this study was done. The Center librarian, Susan Jo Gordos, cheerfully located much source material and deserves special thanks. I am grateful for preliminary typing done by Mrs. Melba Sanders and Janice Dwyer. I am most grateful to Mrs. Sue Koch, who skillfully retyped the entire manuscript and bore the brunt of numerous last minute revisions with considerable good humor--more than I had a right to expect.

Professor Paul Gregory read the entire manuscript and made many valuable suggestions. It is to the members of my committee that my greatest debts are incurred and to whom go my greatest thanks. Professors Curtis and Liew read the final draft of the manuscript. Professor Ryan Amacher and Professor Benjamin J. Taylor, my chairman, both read and commented on numerous drafts and their contributions and encouragement immeasurably aided my progress and the final content of this study.

My wife, Elizabeth, proofread the entire manuscript as well as providing constant encouragement during the long gestation period of this study. My thanks to her are reserved for a more appropriate forum.

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CHAPTER I

THE SOVIET ECONOMY, 1928-1972: AN OVERVIEW

Introduction

In explaining the growth record of the Soviet economy, the most widely adopted technique is to assume a Cobb-Douglas production function exhibiting constant returns to scale.[1] The output elasticities of capital and labor are assumed to be within the same range as output elasticities prevailing in industrialized Western countries. Implicitly, this technique assumes a competitive equilibrium in all markets.[2] Because capital has been, until recently, allocated by the Soviet central planners rather than by any interest rate mechanism, it has been necessary for researchers to "assign" a rate of return to the Soviet capital stock. In deciding which number, or set of numbers,

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[1] This technique is utilized in Stanley H. Cohn, Economic Development in the Soviet Union (Lexington: D. C. Heath and Company, 1970). The output elasticities used are generally within the range 0.60 to 0.75 for labor and 0.40 to 0.25 for capital. In using such elasticities as weights, they must be interpreted as yielding the factor contribution to output if the factors are remunerated in proportion to their marginal productivities.

[2] Michael Bruno, "Estimation of Factor Contribution to Growth Under Structural Disequilibrium," in Studies in Development Planning, ed. by Hollis B. Chenery (Cambridge: Harvard University Press, 1971), p. 359.

is to be assigned, the standard is to pick an interest rate which yields a capital weight similar to that found in Western countries, particularly the United States.[3]

This approach is questionable when determining factor contributions to growth for two reasons. First, as mentioned above, it assumes away the question of disequilibrium relationships, especially in the factor markets. Second, it ignores a growing body of evidence on both socialist and nonsocialist countries pointing to an elasticity of substitution significantly less than one.[4] In view of these difficulties, this study will re-assess the growth performance of the industrial sector of the Soviet

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[3]An example of this approach may be found in Abram Bergson, The Economics of Soviet Planning (New Haven: Yale University Press, 1964) and in Richard Moorsteen and Raymond P. Powell, The Soviet Capital Stock, 1928-1962 (Homewood: Richard D. Irwin, Inc., 1966). There is considerable merit to such an approach when the objective is to determine the relative efficiency of combined factor inputs between the Soviet Union and another country. However, even for this purpose, the technique may be questionable. For a criticism of this method see Philip Hanson, "East-West Comparisons and Comparative Economic Systems," Soviet Studies, XXII (January, 1971), p. 337.

[4]On the evidence in nonsocialist countries see Kenneth J. Arrow, et al., "Capital-Labor Substitution and Economic Efficiency," Review of Economics and Statistics, XLIII (August, 1961), and Murray Brown, On the Theory and Measurement of Technological Change (Cambridge: Cambridge University Press, 1966). For socialist countries see Martin L. Weitzman, "Soviet Postwar Economic Growth and Capital-Labor Substitution," American Economic Review, LX (September, 1970), and Oldrich and Ludmila Kyn, "Factor Productivity in East European Industry," Boston, 1972. (Mimeographed.)

economy since 1928 by utilizing a production function which explicitly accounts for disequilibrium in the factor markets and does not restrict the elasticity of substitution to one. The hypothesis to be tested is: There is no statistically significant structural disequilibrium in Soviet factor markets. Structural disequilibrium is understood to mean that factor prices are not proportional to marginal productivities.

Special attention will be devoted to the postwar period when the increased availability and reliability of data make possible the direct utilization of Soviet sources.[5] The postwar period, especially the decade of the 1960's, has also been one of declining industrial growth. Therefore this period should offer the most fertile ground for testing the effects of structural disequilibrium. In concentrating on the industrial sector of the Soviet economy, the natural proclivity of the Marxian growth model, which focuses its attention on the performance of the industrial sector, is followed.[6] The agricultural sector, while important both as a claimant on Soviet

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[5]See Appendix B for a detailed discussion of Soviet data problems.

[6]Paul Gregory, Socialist and Nonsocialist Industrialization Patterns (New York: Praeger Publishers, 1970), p. xxi. Recently some economists, especially the so-called "radical" economists, have concluded that the Soviet emphasis on the industrial sector was due more to Stalin than to Marx. The difference between a "Stalinist" and "Marxist" development model appears to be largely one of degree.

resources and as a contributor to GNP, exhibits erratic growth trends primarily because of the vagaries of the weather. The distribution of investment and labor resources between industry and agriculture, which has a definite bearing on industrial growth, is not considered here.

The Prewar Period

The performance of the industrial sector from 1928 to 1940 is briefly described in Table 1. During this

TABLE 1

AVERAGE ANNUAL GROWTH RATES,
SOVIET INDUSTRY, 1928-1940

Period	Industry	Agriculture
1928-1940	9.0	1.0
1928-1933	8.0	-4.5
1928-1937	10.3	0.9
1933-1937	13.2	8.3
1937-1940	4.9	3.5

Source: Appendix A, Table 16.

period industrial growth averaged nine per cent per annum. During the First Five-Year Plan the Soviet economy experienced "an enormous reshaping of its transformation function," while during the Second Five-Year Plan the economy "reproduced itself in its own image but on an increasing scale."[7] In 1937 war seemed imminent and the Soviets began a rapid changeover from civilian to military production. Since

[7]Moorsteen and Powell, Soviet Capital Stock, pp. 299-300.

the beginning of the planning period in 1928 industrial output had been quasi-military in nature, that is, capable of being easily converted from civilian to military uses. However, in 1937 the share of munitions in total industrial output began to rise rapidly, as can be seen in Appendix A, Table 8. During the war the Soviet Union experienced a decline in industrial output and large losses in its stock of human and physical capital stock. After the war the inclusion of additional territory within the Union and war reparations partially offset previous losses. Because of the unusual, and nonrecurring, nature of these events, the 1940-1950 period will be excluded from this study.[8]

The prewar growth record of Soviet industry can best be described as extensive. By extensive is meant a growth in output corresponding closely to the growth of the principal inputs, capital and labor, and not to a more efficient utilization of these inputs. Table 2 illustrates how rapidly these inputs grew during this period. While rapid, the rate of increase in investment was not spectacular by historical standards. As Kuznets points out

> the low level of the capital-output ratio in the USSR is not distinctive; it is matched, both in the long run and in the post-World War II years,

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[8]For a description of this period see Raymond P. Powell, "The Soviet Capital Stock and Related Statistical Series for the War Years," in Two Supplements to Richard Moorsteen and Raymond P. Powell 'The Soviet Capital Stock, 1928-1962' (New Haven: The Economic Growth Center, Yale University, 1968).

> by several other countries. What is distinctive about the USSR is the combination of relatively low incremental capital-output ratios with rather high capital formation proportions.[9]

There were however specific differences in the US and Soviet investment patterns. Specifically, the Soviet Union experienced a higher ratio of net to gross investment, a higher percentage of total investment allocated to the industrial sector and, within this sector, a higher percentage of investment funds going to heavy industry.[10] For the U.S.S.R. the ratio of industry to total investment was between thirty-five and forty per cent, the ratio of

TABLE 2

AVERAGE ANNUAL GROWTH, INDUSTRIAL INVESTMENT AND LABOR, 1928-1940

Period	Investment	Labor
1928-1940	10.7	9.4
1928-1933	14.1	11.5
1928-1937	14.6	8.6
1933-1937	15.2	5.0
1937-1940	-0.5	3.7

Source: Table 3 and Table 16, Appendix A.

[9]Simon Kuznets, "A Comparative Appraisal," in Economic Trends in the Soviet Union, ed. by Abram Bergson and Simon Kuznets (Cambridge: Harvard University Press, 1963), p. 357.

[10]Norman M. Kaplan, "Capital Formation and Allocation," in Soviet Economic Growth, ed. by Abram Bergson (Evanston: Row, Peterson and Company, 1953), p. 37.

heavy industrial investment to total investment was twelve per cent and the ratio of net to gross investment was between seventy-five and eighty-five per cent. For the United States the respective figures were twenty-five per cent, eight per cent and fifty to sixty percent.[11]

As Table 2 indicates, the Soviets were able to increase industrial man-hours worked at a rapid rate during the prewar period. This was accomplished, moreover, without the aid of a rapid increase in the population. In lieu of population growth, the Soviets relied on the withdrawal of surplus labor from the agricultural sector for use in industry. Emphasis was also placed on increasing the full-time participation of women in the national economy.

The growth rates in Table 3 serve to illuminate the large structural transformation which occurred during the prewar period. Both population and the total labor force grew relatively slowly. However, the urban population and the industrial labor force grew rapidly while the rural population grew very little and the agricultural labor force actually declined. The hypothesis that in 1928 there was "a surplus agricultural population of 10 to 20 per cent"[12] seems reasonable in view of these trends.

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[11] Ibid., pp. 45, 52, and 56.

[12] Warren W. Eason, "Labor Force," in Economic Trends in the Soviet Union, ed. by Abram Bergson and Simon Kuznets (Cambridge: Harvard University Press, 1963), p. 40.

TABLE 3

GROWTH OF POPULATION AND LABOR FORCE, 1928-1940

Population					
Total		Urban		Rural	
(000's)	(%)*	(000's)	(%)*	(000's)	(%)*
144,900		27,600		122,300	
196,300	2.3	62,000	7.0	134,300	0.8
Labor Force					
86,100		15,500		70,600	
100,800	1.3	40,800	8.4	60,000	-1.5

*Average Annual Rates of Growth

Source: Warren W. Eason, "Labor Force," in Economic Trends in the Soviet Union, ed. by Abram Bergson and Simon Kuznets (Cambridge: Harvard University Press, 1963), pp. 72-73 and p. 77.

Considering only the number of persons in the labor force may obscure many important factors which contributed to the marked increase in industrial output during this period. As Eason has pointed out, the rural-urban movement during this period "raised the level of skills, moderated seasonality and otherwise tended to increase the yearly average number of hours on the job (especially in the

case of females.)"[13] The average annual increase in hours worked per year from 1928 until 1940 was one per cent. However, the average number of females working each workday increased by three per cent per year while the corresponding figure for males was just over one per cent.[14]

Other trends which favored the process of rapid industrial growth include a change in the age distribution of the population and a rapid increase in the skill level of the labor force. Dislocation during the Civil War and the War with the Peasants produced declining birth rates throughout the early 1920's. By 1928 these declining birth rates had changed the age distribution of the Soviet population, increasing the number of persons of working age as a per cent of the total population, which facilitated the achievement of high labor force participation rates. Labor force skill grew rapidly as a result of large-scale on-the-job training programs and increased the educational stock by an average annual rate of between 11.2 and 11.8 per cent from 1926 to 1939.[15] Thus human capital increases were greater than those recorded for physical capital

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[13]Warren W. Eason, "Population and Labor Force," in Soviet Economic Growth, ed. by Abram Bergson (Evanston: Row, Peterson and Company, 1953), p. 106.

[14]Eason, "Labor Force," p. 48.

[15]Stanley H. Cohn, "The Soviet Economy: Performance and Growth," in The Development of the Soviet Economy, ed. by Vladimir G. Treml (New York: Frederick A. Praeger, Publishers, 1968), p. 36.

(see Table 2) and because of the nature of the training received the Soviets were able to achieve this increase in human capital with minimal investment expenditures on the educational infrastructure. Charles Wilber has commented that "trained industrial workers were possibly the most important output of the new factories"[16] during this period.

It was noted earlier that prewar industrial growth was primarily due to an increase in industrial inputs. This argument may be given empirical content by examining the growth of industrial output due, on the one hand, to inputs and, on the other hand, to increases in technology and efficiency. By totaling the two columns of Table 4

TABLE 4

SOURCES OF INDUSTRIAL GROWTH, 1928-1940*

Period	Combined Factor Inputs	Technology and Efficiency
1928-1932	9.9 - 10.7	-2.5 - -3.3
1932-1937	6.7 - 7.3	5.5 - 4.9
1937-1940	5.9 - 6.4	2.7 - 2.3
1928-1940	7.5 - 8.2	1.7 - 1.3

*Average Annual Rates. The ranges given result from the imputation of an eight and twenty per cent rate of return on the Soviet capital stock.

Source: Raymond P. Powell, "Industrial Production," in Economic Trends in the Soviet Union, ed. by Abram Bergson and Simon Kuznets (Cambridge: Harvard University Press, 1963), pp. 171-72.

[16]Charles K. Wilber, The Soviet Model and Underdeveloped Countries (Chapel Hill: The University of North Carolina Press, 1969), p. 103.

the growth rates shown in Table 1 are approximated. Powell's results were obtained by the implicit use of a Cobb-Douglas production function and he admits that "elasticities of substitution between inputs, in the short run and for such extreme changes in factor proportions as occurred, were probably lower than these I assume."[17] This admission, in conjunction with the recent works cited in footnote 3 above, supports the belief that a production function which admits a variable elasticity of substitution such as that to be presented in Chapter 2 may offer a superior analytic framework for examining Soviet economic growth, irregardless of the extent of structural disequilibrium.

A great deal more could be said about the prewar period in Soviet economic history.[18] But additional detail would not obscure the fact that, despite the many problems encountered, Soviet industrial growth throughout this period was rapid. Furthermore, with the exception of the war years, this growth was continued largely unabated through the 1960's, after which growth rates began to decline. An examination of the postwar period is now appropriate.

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[17]Raymond P. Powell, "Industrial Production," in Economic Trends in the Soviet Union, ed. by Abram Bergson and Simon Kuznets (Cambridge: Harvard University Press, 1963), p. 173.

[18]On this period see Alec Nove, An Economic History of the U.S.S.R. (Baltimore: Penguin Books, 1969), Chapters 7-9.

The Postwar Period

Industrial output continued to grow rapidly during the early and middle 1950's. By 1960, however, it was clear even from the Soviet data that the high growth rates of the prewar and postwar recovery years were not being sustained. The decline in industrial growth rates shown in Table 5 has been the subject of much comment by Western scholars. In accounting for this decline attention has centered, as it did in accounting for the rapid growth rates of the prewar period, on the nature and growth of industrial inputs--capital (investment) and labor.

TABLE 5

AVERAGE ANNUAL GROWTH RATES, SOVIET INDUSTRY, 1950-1966

Period	Western Sources	Soviet Sources
1950-1955	10.4	12.7
1950-1958	10.0	11.9
1958-1966	6.7	9.4
1950-1966	8.4	10.8
1966-1972	*	8.3

*Not Available

Source: Appendix A, Table 16; Appendix B, Table 2.

Over the last several years there have been increasingly frequent references to labor shortages in the Soviet press. Apparently shortages are not yet general, being confined to "certain skills and . . . /to/ various

regions and cities."[19] When considering the nature of labor inputs, it is especially true in the postwar period that the number of workers does not reveal the entire situation. Other considerations, such as labor skills, distribution of the labor force by area and occupation and the efficiency with which the available labor force is utilized also play a role.[20]

As Table 6 illustrates, the growth of population since 1950 has been low--an average annual increase of 1.6 per cent--and declining--from a 1.8 per cent average annual rate over 1950-1960 to a 1.1 per cent average annual rate from 1965 to 1968. Low wartime births plus a decline in the crude birthrate from 26.7 per 1000 population in 1950 to 17.3 per 1000 population in 1970 appear to preclude any significant natural population increase in the near future.[21] The changing age-sex distribution of the population resulting from these low birthrates also has intensified the problems associated with a slowly growing population. The able-bodied population has declined

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[19]Murray Feshbach and Stephen Rapaway, "Labor and Wages," in Economic Performance and the Military Burden in the Soviet Union, U. S. Congress, Joint Economic Committee (Washington, D. C.: Government Printing Office, 1970), p. 71.

[20]Warren W. Eason, Panel Discussion, in Dimensions of Soviet Economic Power, U. S. Congress, Joint Economic Committee (Washington, D. C.: Government Printing Office, 1962), p. 18.

[21]Tsentral'noe Statisticheskoe Upravlenie pri Sovete Ministrov S.S.S.R., Narodnoe Khoziaistvo S.S.S.R. b 1970 godu (Moscow, 1971), p. 47.

from 57.3 per cent of the total population in 1950 to 54.6 per cent in 1969. Able-bodied females have declined from 56.6 per cent of total females to 51.9 per cent over the same period.[22]

TABLE 6

AVERAGE ANNUAL GROWTH, POPULATION AND LABOR FORCE, 1950-1968

Period	Population	Total Labor Force	Industrial Labor Force	Agricultural Labor Force
1950-1960	1.8	1.2	3.6	-1.0
1960-1965	1.6	2.0	3.9	-0.7
1965-1968	1.1	1.6	3.5	-2.0
1950-1968	1.6	1.5	3.9	-1.1

Source: Murray Feshbach and Stephen Rapaway, "Labor and Wages," in Economic Performance and the Military Burden in the Soviet Union, U. S. Congress, Joint Economic Committee (Washington, D. C.: Government Printing Office, 1970), p. 75.

While the total labor force grew roughly at the same rate as the population, the industrial labor force grew over twice as fast as the total labor force. The higher industrial labor growth was accomplished by continued absorption of agricultural labor into the industrial

[22]Murray Feshbach, "Population," in Economic Performance and the Military Burden in the Soviet Union, U. S. Congress, Joint Economic Committee (Washington, D. C.: Government Printing Office, 1970), p. 61.

labor force. The residual increase[23] in the labor force was accomplished by increasing participation rates, primarily of females, and by reducing mandatory educational requirements in 1958.[24] The already high participation rates of both sexes, the slow growth in the number of persons reaching sixteen because of declining birthrates and the difficult agricultural situation would indicate the future growth in industrial labor should be more in line with the natural growth of the population.[25]

Coupled with the relatively slow increases in the labor force has been a decline in hours worked per day from 8.0 to 6.67 between 1950 and 1966 and a decline in the days worked per year from 276.3 to 266.4 over the same period. The result has been a decline in hours worked per year from 2210.40 in 1950 to 1754.88 in 1966.[26] While growth in the number of workers was sufficient to sustain an average annual increase in man-hours worked per year of

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[23]Calculated from Table 6 by determining the differential between total labor force growth, industrial labor force growth and the decline in the growth of the agricultural labor force.

[24]These moves were partially offset in 1961 when it was announced that the demobilization of the armed forces was to be discontinued.

[25]The number of males reaching age 17 is expected to increase by an annual average rate of only 0.3 per cent during the decade of the 1970's according to Murray Feshbach, Military Burden in the Soviet Union, p. 68.

[26]Appendix A, Table 11 and Table 16.

2.5 per cent over 1950-1966, actual declines in man-hours worked were recorded in 1960 and 1961.[27] A possible rationale for the Soviet policy of reducing the number of days worked per year was provided by Cohn:

> Since 1958 the U.S.S.R. has reduced the length of the working year far more than any other major nation to a level below that of the other six major economies. This paradoxical policy might be explained in terms of an official policy to substitute additional leisure for goods in consumption policy.[28]

Whatever the rationale, the industrial labor input shows less rapid rates of increase in the postwar period than during the prewar period. However, reductions in hours worked do not signify corresponding reductions in output per man-hour. For Western countries whose labor force participation rates are lower than those in the Soviet Union, it has been estimated that the productivity offset is twenty-five to thirty-five per cent when the work week is reduced from forty-eight to forty hours and

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[27] The work week was to be gradually reduced over the period from 1956 to 1960. Firms with labor reserves were to be the first to make this reduction. Few firms, however, would admit to having reserve labor and as a result the greatest reductions in the work week took place near the end of 1960. For an explanation of this phenomenon see Chapter 2. It should be noted that this decrease in total man-hours worked was a nonrecurring event and that the growth rate of man-hours worked rose to over three per cent per annum in 1962 and has remained at that level.

[28] Stanley H. Cohn, "Soviet Growth Retardation: Trends in Resource Availability and Efficiency," in New Directions in the Soviet Economy, U. S. Congress, Joint Economic Committee (Washington, D. C.: Government Printing Office, 1966), p. 102.

thirty-six per cent when hours worked per day are reduced from eight to seven.[29] Moreover, as the educational and skill level of the labor force increases, the productivity of that labor will rise, providing a further offset to reductions in hours worked. For example, Denison estimates that "education raised the average quality of American labor by 9 per cent (or 0.7 per cent a year)"[30] from 1950 to 1962. From the standpoint of human capital growth, the Soviet decision to decrease mandatory educational requirements appears shortsighted.

As Table 7 illustrates, the growth of human capital has declined markedly since 1960, both in relation to the prewar period and the immediate postwar period. It is small wonder that

> there has been increasing discussion and official statements as to shortages of highly skilled labor, difficulties in finding employment for teenagers who are inadequately trained for industrial occupations [and] inadequate vocational outlets for women and low-skilled persons . . .[31]

As of 1970 only 3.1 per cent of the population possessed a college degree and the average educational attainment of

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[29]Edward F. Denison, Why Growth Rates Differ (Washington: The Brookings Institution, 1967), p. 61. While Denison's study concerned only Western countries, his methodology is used in studies of the Soviet economy. See, for example, Abram Bergson, Planning and Productivity Under Soviet Socialism (New York: Columbia University Press, 1968).

[30]Denison, Why Growth Rates Differ, p. 78.

[31]Stanley H. Cohn, New Directions, p. 115.

the population was 7.3 years of schooling.[32]

TABLE 7

AVERAGE ANNUAL GROWTH OF HUMAN CAPITAL, 1928-1964

Period	Total	Per Worker
1928-1940	13.8	--
1950-1958	7.0	4.9[a]
1958-1961	4.6	3.1[b]
1963-1964	4.6	2.8

[a]1951-1959

[b]1960-1962

Sources: James H. Noren, "Soviet Industry Trends in Output, Inputs, and Productivity," in New Directions in the Soviet Economy, U. S. Congress, Joint Economic Committee (Washington, D. C.: Government Printing Office, 1966), p. 296. Earl R. Brubaker, "Embodied Technology, the Asymptotic Behavior of Capital's Age, and Soviet Growth," Review of Economics and Statistics, L (August, 1968), p. 305. The definition of human capital is that used by Nicholas De Witt, "Costs and Returns to Education in the U.S.S.R.," (Unpublished Ph.D. dissertation, Harvard University, 1962), p. 136.

One mitigating factor which could, under the right circumstances, offset the unfavorable facets of the labor input discussed above is an increase in the efficiency with which the available labor force is utilized. In the past,

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[32]U. S. Bureau of the Census, Estimates and Projections of Educational Attainment in the U.S.S.R.: 1950-1985, by Ann S. Goodman and Murray Feshbach, International Population Reports, Series P-91, No. 16 (Washington, D.C.: Government Printing Office, 1967), pp. 16-17. Such figures are somewhat misleading because higher education in the Soviet Union focuses on the acquisition of technical skills (engineering) whereas higher education in the United States tends more toward liberal arts. On this see Cohn, Economic Development, p. 78.

the Soviets have neglected measures to increase efficiency as the industrialization process "with the exception of certain critical areas . . . emphasized increases in gross production rather than the efficiency in the use of the factors of production."[33] Increasing the efficiency of labor has been especially neglected (until recently) because of the Soviet view that ". . . increased labor productivity in the socialist economy is due, in the main, to new machinery, which facilitates the labor of the workers and greatly increases productivity."[34] This point was indirectly explored by Professor Brubaker, who found that the declining age of the capital stock was an important, but rapidly diminishing, source of Soviet growth.[35]

One may accept, for illustrative purposes, the official Soviet indexes of labor productivity as prima facie evidence that no such increases in the efficiency of labor utilization have occurred. The indexes in Table 8 give output per person working (rabotayushchiny) and per wage worker (rabochiy), the difference being that the former

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[33]John P. Hardt, "Strategic Alternatives in Soviet Resource Allocation Policy," in Dimensions of Soviet Economic Power, U. S. Congress, Joint Economic Committee (Washington, D. C.: Government Printing Office, 1962), p. 7.

[34]M. Yampolsky, "The Planning of Labor," Planovoye Khozyaistivo, 5 (1951), translated in Soviet Studies, IV (July, 1952), p. 93.

[35]Earl R. Brubaker, "Embodied Technology, The Asymptotic Behavior of Capital's Age, and Soviet Growth," Review of Economics and Statistics, L (August, 1968), p. 309.

includes total industrial labor employed while the latter excludes salaried workers.[36]

TABLE 8

AVERAGE ANNUAL INCREASE, INDUSTRIAL LABOR PRODUCTIVITY, 1950-1966

Period	Per Person Working	Per Wage Worker
1950-1955	8.3	7.6
1950-1958	7.6	7.2
1958-1966	5.2	5.6[a]
1950-1966	6.4	6.8[b]

[a]1958-1961

[b]1950-1961

Source: Narkhoz, 1970, p. 64. Soviet data do not contain any adjustment reflecting the decline of the work-week during 1956-1960.

The figures in Table 8 should be considered the upper boundary for labor productivity, and while there are a host of influences embedded in such statistics, the fact that they do indicate a decline in growth is significant.[37] This is especially so as most Western countries show

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[36]Gertrude Schroeder, "Soviet Industrial Labor Productivity," in Dimensions of Soviet Economic Power, U. S. Congress, Joint Economic Committee (Washington, D.C.: Government Printing Office, 1962), p. 142. Presumably Soviet statistics do not include adjustments for increasing skills, increasing effort, greater amounts of capital per worker or managerial improvements which may have taken place.

[37]I say upper boundary because there is reason to suspect that only the most advanced industries are included in the productivity calculations. On this see Schroeder, Ibid., p. 145.

increases in labor productivity per employee.[38] Moreover, there have been no further declines in working hours since 1961 and the number of days worked per year has increased slightly. A partial explanation for the declining productivity growth may "lay in the resort to marginal manpower from agriculture and nonparticipants,"[39] but it seems likely that the inefficient use of available manpower has contributed to the decline.

If the impact of labor on industrial growth is uncertain, the impact of investment looks scarcely less so. As with labor inputs, investment rates continued at prewar levels throughout the early and middle 1950's and declined in the early 1960's. However, during the second half of the 1960's investment growth again was recorded. Since 1965, no corresponding increase in the growth of industrial output has occurred and this fact would seem to indicate a declining marginal productivity of investment. An increase in the average capital-output ratio in industry from 1.76 in 1950 to 2.46 in 1966 confirms this.[40]

There are several explanations for the rising capital-output ratio. Perhaps the most important concerns the allocation of investment funds. Professor Nutter has

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[38] Stanley H. Cohn, New Directions, p. 104.

[39] Ibid., p. 113.

[40] Moorsteen and Powell, Soviet Capital Stock, p. 367, and Moorsteen, Powell and Becker, Two Supplements, p. 27.

noted that in concentrating investment in such primary sectors as steel, fuels, electric power capacity and standard machine tools, the Soviets chose industries where they could expect to reap the greatest economies of scale.[41] Once such economies have been achieved, the investment mix should shift in favor of the secondary and tertiary sectors where such economies are neither as great nor as easily obtained.

TABLE 9

AVERAGE ANNUAL GROWTH OF INVESTMENT, BY ECONOMIC SECTOR, 1950-1969

Economic Sector	1950-1960	1960-1965	1965-1969
Total	12.7	6.3	7.0
Consumer Oriented:	14.0	5.6	8.2
Agriculture	12.1	11.9	8.4
Consumer Goods	14.3	3.4	7.6
Housing	15.1	-0.1	7.1
Services	14.1	7.5	9.5
Producer Oriented:	11.1	7.3	5.2
Construction	13.5	5.1	14.0
Heavy Industry	11.3	7.5	4.8
Transportation and Communications	9.3	7.2	3.6

Source: Scot Butler, "The Soviet Investment Program," in Economic Performance and the Military Burden in the Soviet Union, U. S. Congress, Joint Economic Committee (Washington, D. C.: Government Printing Office, 1970), p. 52.

[41] G. Warren Nutter, "On Measuring Economic Growth," Journal of Political Economy, 65 (February, 1957), pp. 51-63.

It is clear from Table 10 that since 1950 shifts in the pattern of investment have taken place. Most noticeable is the decline in the share of heavy industry and the increase in the share of agriculture. If the inability of agriculture to continue to release labor for use in industry may be considered a growth-retarding factor, the increasing share of the investment ruble claimed by agriculture may be equally retarding. The Soviets have avoided making the large-scale agricultural investments necessary for equipment modernization and irrigation projects. But recurring agricultural crises may mean such investments can no longer be postponed and the Ninth Five-Year Plan calls for a further

TABLE 10

INVESTMENT SHARES, BY ECONOMIC SECTOR, SELECTED YEARS

Economic Sector	1950	1960	1965	1969
Total	100.00	100.00	100.00	100.00
Consumer Oriented:	51.34	57.74	55.80	58.43
Agriculture	14.30	13.61	17.59	18.86
Consumers Goods	4.69	5.41	4.70	4.82
Housing	18.40	22.85	16.74	16.73
Services	13.93	15.84	16.75	16.73
Producer Oriented:	48.65	42.25	44.75	41.56
Construction	2.63	2.84	2.69	3.54
Heavy Industry	33.67	29.87	31.56	29.21
Transportation and Communications	12.34	9.54	9.94	8.79

Source: See Table 9.

increase in the agricultural share of investment to 21.63 per cent by 1975.[42]

The nature of the shifting investment pattern emerges somewhat more clearly in Table 11. The percentage of

TABLE 11

DISTRIBUTION OF INDUSTRIAL INVESTMENT FUNDS, BY SECTOR, PERCENTAGES, SELECTED YEARS

Industry	1950	1960	1965	1970
All Industry:	100.00	100.00	100.00	100.00
Ferrous Metallurgy	10.89	9.40	8.72	8.61
Chemicals and Petrochemicals	3.96	7.02	10.36	8.90
Fuels	30.64	18.28	20.06	19.91
Electric Power	8.81	11.22	12.12	11.97
Machine Building	15.08	14.10	15.58	17.54
Construction	3.05	7.86	4.89	4.99
Timber	5.47	5.60	5.47	4.94
Consumer Goods	12.23	15.34	12.98	13.72
Others	9.82	11.14	9.77	9.37

Source: See Table 10.

industrial investment funds allocated to ferrous metallurgy and fuels has declined while the investment share in machine building has increased slightly. Even so, these figures fail to record the increasing diversity, i.e.,

[42] Gosplan, Gosudarstvennyi piatiletnii plan razvitiia narodnogo khoziaistva SSSR na 1971-1975 gody (Moscow: Political Literature Publishing House, 1972), p. 225.

away from the standard machine tools, in that industry.[43] Of the industries mentioned by Nutter, only electric power is still receiving an increasing share of investment funds--a reflection of the fact that the electrification of the countryside, long an important Soviet goal, has not yet been completed.[44] By contrast, the investment share of chemicals is up considerably, construction and consumer goods shares are up slightly and the remaining industries show little change.

While the level and distribution of investments have undoubtedly played a role in the growth slowdown, they are neither necessary nor sufficient conditions for such a decline. Part of the burden must fall on the inability of the Soviet planning apparatus to generate sufficient technological improvements. Gerschenkron has argued that:

> Because technological progress can be introduced into the process of replacement of worn-out machinery, a zero rate, or even a negative rate of investment can be perfectly compatible with economic growth . . .[45]

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[43]Anthony Daukas, "Machine Tool Production in the United States and U.S.S.R.," in Dimensions of Soviet Economic Power, U.S. Congress, Joint Economic Committee (Washington, D. C.: U. S. Government Printing Office, 1962), p. 172.

[44]One of Lenin's favorite slogans was "Communism is Soviet Rule plus the electrification of the countryside."

[45]Alexander Gerschenkron, Economic Backwardness in Historical Perspective (Cambridge: Harvard University Press, 1962), p. 268.

It is widely acknowledged that the Soviet Union is, relative to the United States and Western Europe, technologically "backward," and this backwardness is especially pronounced in certain industries receiving a high percentage of the Soviet investment ruble--chemicals, petroleum, transportation, consumer durables and farming.[46]

The propensity of Soviet enterprises to employ technologically obsolete equipment may be partially explained by artifically low depreciation charges. In 1963 the share of depreciation in gross investment in the U.S.S.R. was less than half that of the United States and the 1963 figure (22.9 per cent) represented a forty-one per cent increase over the previous year.[47] But a more likely explanation lies in the inability of the managerial bonus system to motivate, at the micro economic level, the type of on-going technological innovations necessary in a modern industrial sector.[48]

Obsolescence is not the only problem hindering the efficiency of capital investments. Recently the Soviet economy has experienced "sharp increases in the volume of unfinished construction and uninstalled equipment . . ."[49]

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[46]Greenslade, New Dimensions, p. 6.

[47]Cohn, New Dimensions, p. 121.

[48]For a discussion of this problem see Eirik G. Furubotn and Svetozar Pejovich, "Property Rights and Economic Theory: A Survey of Recent Literature," Journal of Economic Literature, X (December, 1972), p. 1155.

[49]Cohn, New Directions, p. 102.

This is an especially worrisome problem because planners count the output of new plants from the day they are *scheduled* for completion rather than from the day of *actual* completion. Another problem concerns production disruptions. It is estimated that the number of wage workers "employed in the repair and servicing of plant and equipment . . . is nearly twice as high as that in the United States."[50] There are no capacity utilization data for Soviet industry but judging from the large number of repair workers and from labor time lost because of breakdowns on the production line, lower capacity utilization is probably a drag on industrial growth which has not been offset by higher rates of investment since 1965.

Finally, a word on the impact of defense expenditures on industrial growth. The defense expenditures shown in Table 12, based on official Soviet budget data, probably underestimate the actual expenditures and also the opportunity costs associated with these expenditures. National defense, and especially the Soviet space program which is included in defense spending, requires highly skilled technicians and precision equipment.[51] Because

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[50] Schroeder, *Dimensions*, p. 160.

[51] Greenslade, *New Directions*, p. 6. Defense-related expenditures are not included separately in Soviet handbooks and it is impossible to determine the exact amounts of such expenditures. For this reason Weitzman (see footnote 3 above) argues that, for the postwar period, Western indexes of Soviet industrial production may be no better than indexes obtained directly from Soviet sources.

these are also requirements in a modern industrial sector, the opportunity costs of the Soviet defense establishment may be much higher than these ruble outlays indicate.

TABLE 12

SOVIET DEFENSE EXPENDITURES, EXPLICIT
(1950 = 100)
(BILLIONS, RUBLES)

Year	Monetary Outlays	"Real" Outlays
1950	100	100
1955	130	144
1960	111	168
1965	154	246
1967	176	278

Source: Abram Bergson, "Soviet Defense Expenditures," presented to the Subcommittee on Economy in Government, U. S. Congress, Joint Economic Committee, June 24, 1969, (mimeographed.), p. 2.

Despite the tentative nature of the above figures, they do exhibit some interesting trends. Real outlays grew at an average annual rate of 6.2 per cent over 1950-1967 but within this period rates of growth were quite divergent: 7.6 per cent from 1950-1955, 3.0 per cent from 1955-1960 and 7.6 per cent from 1960-1967. By 1967 it is estimated that Soviet defense expenditures were "approaching, if they had not surpassed, the peak level reached in 1944, during World War II."[52] During the postwar period Stanley

[52]Abram Bergson, "Soviet Defense Expenditures," presented to the Subcommittee on Economy in Government, U. S. Congress, Joint Economic Committee, June 24, 1969, (mimeographed.), p. 2.

Cohn concludes that lower levels of defense spending by the Soviets would have had only a minimal effect on investment growth, but a substantial effect on labor productivity (via the incentive effect of increased availability of consumers' goods) and on the productivity of fixed capital (through the transfer of highly skilled labor into non-defense related areas).[53]

Discussions of the distribution and utilization of capital and labor usually preceed explanations of declining growth in factor productivity, which were thought to be "the main reason for the Soviet /growth/ slowdown."[54] Calculations of joint factor productivity generally proceed from the "usual" production function form (where the dots indicate time derivatives):[55]

$$(1) \qquad \dot{Q}/Q = \dot{A}/A + a(\dot{K}/K) + (1-a)(\dot{L}/L),$$

where a is the income share of capital. Calculations of total factor productivity do indicate a substantial decline for the Soviet economy--from 3.1 per cent per annum over the 1950-1955 period to 0.9 per cent per annum from 1960 to 1966.[56] But in (1) $\dot{A}/A$, or total factor productivity,

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[53]Stanley Cohn, "The Economic Burden of Soviet Defense Outlays," in Economic Performance and the Military Burden in the Soviet Union, U. S. Congress, Joint Economic Committee (Washington, D. C.; Government Printing Office, 1970), pp. 166-68.

[54]Weitzman, "Soviet Postwar Economic Growth," p. 684.

[55]Richard R. Nelson, "The CES Production Function and Economic Growth Projections," The Review of Economics and Statistics, 47 (August, 1965), p. 326.

[56]Moorsteen and Powell, The Soviet Capital Stock, p. 379.

is expressed as a function of time, assumed to be unrelated to input changes and to raise the productivity of capital and labor in identical proportions.[57] On the basis of these assumptions, by "postulating the equality of factor prices and marginal products, relative shares would thus be invariant to shifts in the function."[58] The CMS function presented in Chapter 2 provides for a quite different behavior of total factor productivity (see page 47 below) and an alternative explanation for its decline.

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[57] Bela Balassa, "The Dynamic Efficiency of the Soviet Economy," American Economic Review, 54 (May, 1964), p. 492.

[58] Ibid., p. 492.

CHAPTER II

STRUCTURAL DISEQUILIBRIUM AND THE CMS PRODUCTION FUNCTION

Introduction

References to structural disequilibrium are often encountered in the literature on economic development. A specific definition of this phenomenon was given by Kindleberger and Despres:

> Disequilibrium at the factor level may arise either because a single factor receives different returns in different uses or because the price relationships among the factors are out of line with factor availabilities.[1]

Structural disequilibrium is frequently thought to occur in underdeveloped countries characterized by unlimited supplies of labor, especially in the agricultural sector. In this instance, unlimited is taken to mean that at some institutionally determined subsistence wage rate "the supply of labor at this price exceeds the demand."[2] This labor surplus situation is usually considered to exist side-by-side with a relative capital shortage, that is, given the existing techniques of production, the "correct" utilization

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[1] C. P. Kindleberger and E. Despres, "The Mechanism for Adjustment in International Payments--The Lessons of Post-war Experience," American Economic Review, Papers and Proceedings, XXXII (May, 1952), p. 333.

[2] W. Arthur Lewis, "Economic Development with Unlimited Supplies of Labor," in The Economics of Underdevelopment, ed. by A. N. Agarwala and S. P. Singh (London: Oxford University Press, 1969), p. 403.

of capital and labor inputs will result in disguised unemployment or underemployment of the relatively abundant labor factor.

The development prescription in such a situation is to economize on the use of capital by employing investment funds primarily in the industrial sector. As a capital base is built in the industrial sector, surplus labor may be withdrawn from the agricultural sector to be used in conjunction with the newly acquired industrial capital stock. Industrial output will increase because of the employment of additional capital and labor. Agricultural output should not fall, and may in fact rise slightly, since the labor withdrawn from this sector is only marginally productive.[3] Important sources of marginally productive labor are "farmers, the casuals, the petty traders, the retainers (domestic and commercial), women in the household, and population growth."[4]

The situation described above is very likely that which prevailed in the Soviet Union in 1928. Chapter I has already alluded to the surplus labor in agriculture, the increasing labor force participation of females, and the high percentage of investment funds devoted to the

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[3]For a complete description of a labor surplus model see John C. H. Fei and Gustav Ranis, Development of the Labor Surplus Economy (Homewood: Richard D. Irwin, Inc., 1964).

[4]W. Arthur Lewis, The Economics of Underdevelopment, pp. 405-06.

industrial sector. However, the rapidity of the structural transformation which occurred in the U.S.S.R. between 1928 and 1937 indicates that this situation did not long prevail. It is not possible to conclude that after 1937 factor prices were no longer out of line with factor availabilities, however, for three reasons.

First, until very recently capital received no charge in Soviet cost accounting. Allocations of investment funds were made according to the dictates of the central planners. Since the marginal productivity of investment was most certainly not zero, the existence of a zero price for capital is not consistent with an equilibrium price. Labor of course was not zero-priced. As a result, an efficient combination of capital and labor, i.e., "that combination for which the marginal rate of equal-product substitution of capital for labor is the same in each industry and equal to the equilibrium price ratio"[5] was impossible. When a capital charge, or "norm of effectiveness," was introduced in 1959, this charge varied from industry to industry. The effects of structural disequilibrium might be mitigated by the use of a differential

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[5]Judith Thornton, "Differential Capital Charges and Resource Allocation in Soviet Industry," Journal of Political Economy, 79 (May/June, 1971), p. 546.

capital charge, but they would not be eliminated.[6]

Second, there is good reason to believe that wages were not proportional to the marginal productivities of labor, especially during the postwar period. Two factors support this conclusion: the existence of what Joseph Berliner has termed "the safety factor" and the Soviet commitment to full employment. The safety factor, or strakhovka, refers to "holding back a reserve, of preserving 'slack' in the drafting and execution of plan targets, so that if anything goes wrong management will have untapped resources to fall back upon in order to meet its targets."[7] In order to insure labor reserves, managers attempt to retain labor not needed in the current production process. The excess labor can then be utilized if plan targets are raised or if there is difficulty in meeting the current targets. In order to secure a sufficient wage fund, work orders will be falsified, that is,

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[6]To say a differential capital charge might eliminate some of the effects of structural disequilibrium presupposes that enterprise managers adjust factor proportions in response to changes in relative prices. It is not at all clear that this is the case. In 1969 a new norm was introduced which introduces a uniform value for the coefficient of relative effectiveness. But various adjustments may be made in this uniform value to account for regional and other differences. On this see Alan Abouchar, "The New Soviet Standard Methodology for Investment Allocation," Soviet Studies, XXIV (January, 1973), pp. 404-05.

[7]Joseph S. Berliner, Factory and Manager in the USSR (Cambridge: Harvard University Press, 1957), p. 76.

wages will be paid to certain workers when, in fact, no work or less work than is stated has actually been performed.[8]

Finally, the Soviet policy of maintaining full employment may also lead to disequilibrium relationships in the labor market. In 1930 unemployment was officially declared nonexistent in the Soviet Union. Of course frictional unemployment is certain to exist, but the Soviet system of labor reporting fails to record this. In order to prevent unemployment, managers are under pressure to retain employees (over and above the strakhovka) who, either because of lack of skills or lack of job discipline, are marginally productive. This leads to a policy of "overemployment . . . where marginal productivity is below the wage-earner's income (or negative if output is the criterion), that is, reallocation of employees to other uses would produce net gains (in terms of output)."[9]

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[8] Ibid., p. 173. In this regard the Shchenkino experiments which began in 1967 are interesting. At Shchenkino, a large chemical complex, the enterprise wage fund was fixed for a period of three years. Any reduction in the number of workers therefore created a "surplus" which would be divided among the remaining personnel. Over a three-year period employment was reduced and wages at Shchenkino increased more rapidly than the industry average. This type of experiment eventually covered more than 400,000 workers, but by 1970 the amount of enterprise autonomy allowed was considerably reduced. On this see Leonard Joel Kirsch, Soviet Wages (Cambridge: The MIT Press, 1972), p. 147.

[9] George R. Feiwel, The Soviet Quest for Economic Efficiency (New York: Praeger Publishers, 1972), p. 449.

An overemployment policy is conceptually similar to the underemployment hypothesis, usually associated with less developed countries, of Lewis and Fei and Ranis. In the underemployment hypothesis, agricultural labor receives a wage in excess of marginal productivity because labor is in excess supply relative to the existing industrial capital stock. During the development process, this excess labor is withdrawn from agriculture as an industrial capital stock is acquired. This process may be a protracted one, but the original factor disequilibrium is self-correcting provided sufficient industrial development is achieved.

The Soviet policy of overemployment is the result of rapid industrial development and a commitment to full employment. During the early stages of industrialization, the Soviet industrial capital stock expanded more rapidly than the stock of skilled labor necessary to utilize this capital efficiently. In lieu of a smaller, highly skilled labor force, enterprise managers resorted "to employing a larger labor force to ensure execution of plan assignments."[10] Because Soviet policy stressed the growth of inputs rather than their efficient use, enterprise employment of excess labor continued. As the Soviet economy matured, labor became relatively less abundant; to continue to attract excess labor (over that required by existing production techniques), enterprise managers increased wages

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[10] Ibid., p. 447.

faster than warranted by productivity increases. This type of behavior is unofficially condoned (although officially condemned) by the refusal of Soviet ideology to admit even temporary unemployment. The economic effects of over-employment are the same as those of underemployment; factor markets are characterized by structural disequilibrium.

FIGURE 1

OVEREMPLOYMENT IN THE SOVIET ENTERPRISE

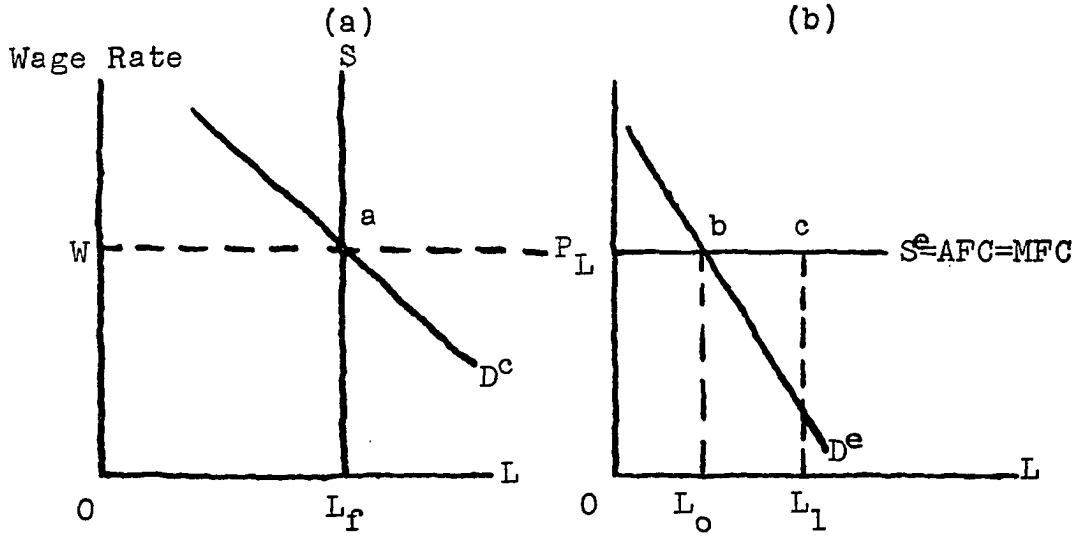

Figure 1 depicts such an overemployment situation. The aggregate supply curve, S, is perfectly inelastic at L_f, the level of full employment. The central planners' demand for labor, D^c, reflects the information they have received from enterprises and statistical associations on technical coefficients, labor productivity, etc. The aggregate wage fund becomes $OWaL_f$. At the enterprise level (Figure 1b), D^e is the demand for labor for a given firm as envisaged by the central planners. The perfectly elastic supply

curve, S^e, reflects the planners assumption that the necessary labor will be available. The enterprise will be allocated a wage fund of OP_LbL_o, where P_L is the average wage rate of the enterprise which may or may not be equal to the average wage rate for the entire economy. The only requirement here is that the sum of the enterprise wage funds does not exceed the aggregate wage fund.

Suppose the enterprise hires not OL_o labor as the central planners expect but OL_1. There are two possible reasons for this type of enterprise behavior. First, because of the safety factor the enterprise director may have in mind a demand curve which intersects S^e at c rather than b. If this is true, the enterprise will overspend its wage fund allocation by L_obcL_1. Or D^e may reflect a leftward shift in the demand for labor (intersecting S^e now at b rather than at c) occasioned by the recent installation of labor-saving equipment. Rather than discharge the displaced workers, enterprise managers may simply reassign them to other jobs within the plant. Another variant of the overemployment argument might be as follows: both the central planners and the enterprise agree on the labor demand curve D^e but the enterprise director is requested by local Party officials to employ his "share" (L_oL_1) of new entrants into the labor force. Whichever might be the case, the result is again an overspending of the wage fund by L_obcL_1. In spite of severe penalties for exceeding the wage fund allocation, the Soviet press is replete with

examples of such behavior on the part of enterprise managers.[11] The central planners may tolerate this behavior because they recognize the safety factor as a necessary cost in meeting output targets and because the ideological commitment to full employment would not permit the discharge of excess labor even if the safety factor were not tolerated.[12]

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[11]Leonard Joel Kirsch, Soviet Wages, p. 32. There are various ways in which the enterprise wage fund allocation may be exceeded. First, an enterprise whose production is designated high priority may receive additional funds if the director is able to convince superior agencies that additional labor is necessary for the fulfillment of output targets. Second, if an enterprise director is willing to forgo bonus funds due him for meeting the wage fund targets, he may receive additional allocations. This will happen if the loss of these bonus funds is small in relation to the bonuses he will receive for fulfilling other targets.

[12]There are many other reasons for suspecting overemployment at the enterprise level. Enterprises are expected to find other employment opportunities for discharged employees. It is often easier for the enterprise to retain such workers than to incur job search costs. In some enterprises, managerial bonus funds are tied to the size of the wage fund. This creates an obvious managerial incentive to keep the labor force, and hence the wage fund, as large as possible. The extent of this overemployment often emerges from the reports of foreign companies that design entire factories for use in the Soviet Union. In six chemical plants designed by a foreign firm, the auxiliary workers necessary according to the original plans were 91. Before the plants were completed, Soviet planners had raised their number to 430. The actual number of auxiliary workers on the job when the plants were in full production numbered 723. On all of this see Feiwel, Economic Efficiency, pp. 444-64. Note also that the existence of an upward sloping supply curve for the enterprise would, assuming wages were allowed to rise and skilled labor is thereby attracted, still result in wage fund overspending and excess employment. However, the magnitudes of both would depend on the respective elasticities of supply and demand. Another possible explanation for lack of proportionality between wages and marginal productivities was

Until recently, researchers have not attempted to empirically verify the extent of disequilibrium in the Soviet Union.[13] Instead, the concentration has been on determining the productivity of combined factor inputs on the basis of a Cobb-Douglas production function (see Table 4).[14] The problems in verifying the extent of structural disequilibrium have been two-fold: an inadequate theoretical framework and the paucity of Soviet data necessary to make such an attempt. The latter is now less of a problem, as was pointed out in Chapter I and Michael Bruno has developed a production function which explicitly accounts for disequilibrium in the factor markets.[15] This production function, the constant-marginal-shares (CMS) function is presented in the following section.

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suggested, but not tested for the Soviet Union, by Paul R. Gregory, "A Model of Socialist Wage Differentials: The Case of East Germany," Quarterly Journal of Economics, LXXXVII (February, 1973), p. 133. Gregory argues that central planners will tend to overestimate the wage differential necessary to attract workers to priority branches.

[13]The exceptions are Judith Thornton, "Differential Capital Charges," Yasushi Toda, "Estimation of a Cost Function in the State of Structural Disequilibrium: The Case of Soviet Manufacturing Industry, 1960-1969," presented to the Econometric Society Winter Meeting, Toronto, December 28, 1972, and L. V. Kantorovich, The Best Use of Economic Resources, trans. by P. F. Knightsfield (Cambridge: Harvard University Press), 1965.

[14]Other examples of this method may be found in Abram Bergson, "Comparative Productivity and Efficiency in the Soviet Union and the United States," in Comparison of Economic Systems, ed. by Alexander Eckstein (Berkeley: University of California Press, 1971), and the sources cited therein.

[15]Michael Bruno, "Estimation of Factor Contribution to Growth," pp. 360-61. The model outlined in the next section is taken, unless otherwise indicated, from these pages.

The CMS Production Function

As in Arrow, Chennery, Minhas and Solow a linear relationship between output per unit of labor, Q/L, and the real wage rate, w, is postulated:[16]

(1) $Q/L = c\ w + d$; where $c > 0$, $d \gtreqless 0$.

In equation (1) c and d are share parameters and are a function of the institutional and technological conditions as equations (2) and (3) will show. Equation (1) implies a constant marginal labor share and an average labor share which will rise, fall, or remain constant depending on the value of d.

There will also exist an aggregate production function which will yield a linear relationship between the marginal product of labor, $\partial Q/\partial L$, and the real wage:

(2) $\partial Q/\partial L = p\ w + q$; where $p > 0$, $q \gtreqless 0$.

The parameters of equation (2), p and q, are assumed to be fixed and dependent on the institutional setting of the economy.

The general form of the production function yielding equations (1) and (2) can be derived by solving equation (1) for w, substituting the result into equation (2) and solving the resulting differential equation. To aid this and make explicit the relationship of the share parameters (c,d) and the technological conditions, two new parameters, a and m, are assumed to relate to the parameters

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[16] See footnote 3, Chapter I.

of equations (1) and (2), c, d, p and q, through the following transformation:

$$(3) \quad c = {}^{P}/_{1-a}, \quad d = {}^{q+ma}/_{1-a}.$$

Both a and m are fixed technological parameters, the former being the capital share in the aggregate production function to be specified below and the latter, if $m > 0$, indicates the loss of output due to disequilibrium in the labor market.

Equations (1), (2) and (3) yield the following partial differential equation:

$$(4) \quad {}^{\partial Q}/_{\partial L} = (1-a)\ {}^{Q}/_{L} - ma.$$

From the integration of (4) a general production function may be obtained:

$$(5) \quad Q = C\ (K,t)\ L^{1-a} - mL.$$

In (5), C, the constant of integration, contains the variables not appearing in (4) but which are known to be present in the production function. These variables are the capital stock (K), time (t) and a parameter denoting technological progress (λ). This model will deal with the constant returns to scale case with exponential technological progress, therefore, $C(K,t) = Ae^{\lambda t}K^{a}$ where A is a constant. With C specified, the explicit form of the aggregate production function becomes

$$(6) \quad Q = Ae^{\lambda t}K^{a}L^{1-a} - mL$$

which may be rewritten as

$$(6a) \quad y = Ae^{\lambda t}x^{a} - m, \quad \text{where } y = Q/L \text{ and } x = K/L.$$

As was indicated above, equations (6) and (6a) assume that any departure from perfectly competitive, profit maximizing equilibrium conditions will result in a loss of output, hence the minus sign preceeding $\underline{m}$. If $m = 0$, then (6) and (6a) reduce to constant marginal share Cobb-Douglas production functions. However, if $m > 0$, both will yield variable elasticity of substitution production functions in which the elasticity of substitution approaches one as Q/L increases over time.

In equation (2), if $\underline{p} > 0$ and $\underline{q} = 0$ this is not evidence of the type of structural disequilibrium dealt with here. Rather, this would indicate an imperfectly competitive labor market in which wages are proportional, but not equal, to marginal productivities. Such a case would not, of course, violate the assumptions of marginal productivity theory. Only if $q \neq 0$ can it be said that structural disequilibrium is present.

In a two factor production function, if one factor receives a return greater (less) than its marginal productivity, the other factor must receive less (more) than its marginal productivity. In this model, the disequilibrium relationship in the capital market would be

$$(7) \quad \partial Q/\partial K - r = -1/\chi(\partial Q/\partial L - w).$$

It was mentioned above that the CMS function will, under certain conditions, yield a variable elasticity of substitution of capital for labor. Using the familiar symbols for first and second partial derivatives, equation

(6a) yields the following formula for the elasticity of substitution:

$$(8) \quad \bar{\sigma} = y'(y - xy')/xyy'' = 1 - (am/1-a)(1/y).$$

In (8), if $m > 1$ then σ will be less than one and will approach one or zero depending on whether y increases or decreases over time.

This behavior of the elasticity of substitution is instructive for the Soviet case. Recent studies have shown the elasticity of substitution to be less than one in the U.S.S.R. Weitzman, in fitting a CES function to the postwar concluded that because of the low elasticity of substitution (0.403)

> capital accumulation has outstripped labor growth by a wide enough margin that the drag due to diminishing returns is significantly cutting into output growth. In the mature Soviet economy, labor scarcity appears to be a reality.[17]

This raises an interesting question: Is the labor scarcity Weitzman alludes to and to which many Soviet economists also allude real, or is it the result of a combination of a no unemployment policy at the macro level and a safety factor policy at the micro level, both producing overemployment. If the latter should be the case, then the growth retardation of the 1960's may not, as some have suggested, be the inevitable result of a maturing Soviet

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[17]Weitzman, "Soviet Postwar Economic Growth," p. 685.

economy but the accidental result of irrational policies.[18]

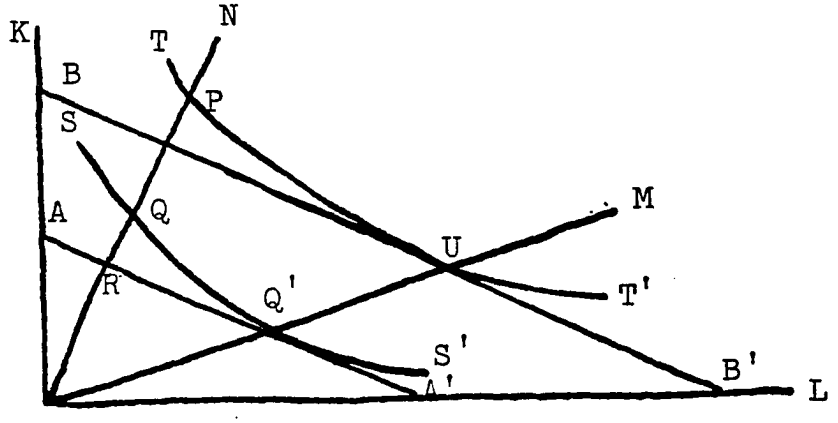
At this point it is no longer possible to continue to ignore the irrationality of the Soviet price system. It was M. J. Farrell who pointed out that it is possible to distinguish two types of inefficiency: price inefficiency and technical inefficiency.

> The former measures a firm's success in choosing an optimal set of inputs, the latter its success in producing maximum output from a given set of inputs.[19]

The difference between the two inefficiencies may be shown by the following diagram.[20]

FIGURE 2

MEASUREMENT OF PRICE AND TECHNICAL INEFFICIENCY



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[18]For analysis of the view that Soviet growth retardation was inevitable see Abram Bergson, "Toward a New Growth Model," Problems of Communism, XXII (March-April, 1973), and Judith Thornton, "Factors in the Recent Decline in Soviet Growth," Slavic Review, XXV (March, 1966).

[19]M. J. Farrell, "The Measurement of Productive Efficiency," Journal of the Royal Statistical Society, Series A (General), 120 (1957), p. 259.

[20]Ibid., pp. 254-55.

The various combinations of capital and labor that could be utilized by a firm with no technical inefficiency is represented by SS'. AA' reflects the input price ratio which would prevail if factor prices reflected marginal productivities. Point P represents the observed inputs utilized by the firm, and ON the observed production path. In this case the ratio OQ/OP would be a measure of the technical efficiency of the firm. A firm having no price inefficiency would be at point Q'; therefore, the ratio OR/OQ would measure the price efficiency of the firm. The overall efficiency of the firm would be represented by the ratio OR/OP.

The CMS function will provide some measure of the overall efficiency of Soviet industry. Equation (2) will confirm or deny the existence of price inefficiency but the final form of the production function (Equation (6)) will include both price and technical inefficiency. Because both $\underline{q}$ and $\underline{m}$ will be industry averages, nothing can be determined concerning the relative efficiency of individual industry groupings, that is, it will be impossible to say the steel industry is more efficient than the fuels industry. One may think of $\underline{m}$ in equations (6) and (6a) as reflecting the inability of Soviet industries to move to isoquant TT' (representing no technical inefficiency) and onto production ray OM to point U (no price inefficiency).

It was pointed out in Chapter I that the CMS function provides an alternative explanation for the declining growth of total factor productivity. This difference can be illustrated by taking the derivative of equation (6) with respect to time:[21]

$$(9)\quad \dot{Q}/Q = (1/Q)(\partial Q/\partial L) + E_1(\dot{L}/L) + E_2(\dot{K}/K),$$

where $(1/Q)(\partial Q/\partial L)$ is total factor productivity and E_1 and E_2 are the respective relative contributions of labor and capital to growth. In the case of constant returns to scale, these magnitudes are identified as follows:

$$(10a)\quad (1/Q)(\partial Q/\partial L) = \lambda(1 - m/y)$$

$$(10b)\quad E_1 = 1 - a(1 - m/y)$$

$$(10c)\quad E_2 = 1 - E_1.$$

If the existence of structural disequilibrium is verified from the data, i.e., if $\underline{m} > 0$, then "the role of the 'total productivity' factor decreases over time, as $\underline{y}$ increases."[22] The problem with total factor productivity, also referred to as the "residual" or perhaps more accurately as "the measure of our ignorance,"[23] is that it is most difficult to determine what growth factors this magnitude reflects. Weitzman has suggested several factors: "increasing returns, labor skills, optimal use of resources and better

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[21]Michael Bruno, "Estimation of Factor Contribution to Growth," p. 368.

[22]Ibid., p. 368.

[23]Bela Balassa, "The Dynamic Efficiency of the Soviet Economy," p. 492.

organization."[24] The CMS model seeks an explanation in the optimal use of resources, as the other factors seem less promising. Brubaker has shown that if labor skills (human capital) are included as a separate factor of production, the size of the residual is reduced by an inconsequential amount.[25] Because time series analysis does not permit the differentiation between scale and time effects, this aspect must be left to future research. The effects of better organization, what Leibenstein has termed "X-efficiency,"[26] might be indirectly tested by partitioning the postwar period into two subperiods: 1950-1965 and 1966-1972. The difference in the behavior of the residual, if any, between these two periods would provide some suggestion of the efficiency impact of the 1965 economic reforms. Unfortunately the observations are too limited to admit this procedure.[27]

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[24] Martin L. Weitzman, "Soviet Postwar Economic Growth," p. 686.

[25] Earl R. Brubaker, "Embodied Technology," p. 305.

[26] Harvey Leibenstein, "Allocative Efficiency vs. 'X-Efficiency'," in Comparative Economic Systems: A Reader, ed. by Marshall I. Goldman (New York: Random House, Inc., 1971), p. 74.

[27] In matrix notation one would employ the following regression models:

$$Y_i = \alpha_i + \beta_i X_i + e_i \qquad i = \text{pre-1966 observations}$$

$$Y_j = \alpha_j + \beta_j X_j + e_j \qquad j = \text{post-1966 observations}$$

$$Y_k = \alpha_k + \beta_k X_k + e_k \qquad k = \text{total observations.}$$

The null hypothesis would be $\alpha_i = \alpha_j = \alpha_k$, where $\alpha = \beta_o$

Structural Disequilibrium in the Soviet Union

Turning now to the plausibility of the CMS model for Soviet industry, the question is: Are the assumptions that labor received a wage not proportional (and greater) than its marginal productivity and therefore that capital also received a return not proportional (but less) than its marginal productivity, valid for the Soviet case? In describing the environment in which the CMS function might be valid, Bruno suggests that

> . . . we are dealing with an economy in which funds for investment are more or less rationed, and there is little in the way of a price-regulated market for capital. It does not matter whether this takes the form of an ultimate limitation imposed by availability of foreign exchange (with which machinery has to be bought), or whether the effective bottleneck is the supply of savings, with the government financing development through inflationary but controlled credit expansion. . . . It suffices for our purposes to assume that there is no market in which capital can be acquired at will and with everybody scrambling to equate the marginal productivity of capital to a going rental rate. The rate of interest which the government or a foreign agency would charge for a development loan is way below the real or shadow rate, as measured by the long-run marginal productivity of the same.[28]

Although Bruno was describing the economy of Israel, the description is an apt one for the Soviet economy, where capital is not obtained freely in the market but allocated centrally. Bruno assumes profit-maximizing behavior on

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in equation (5c), Chapter III. If the null hypothesis is not rejected, one would conclude that the 1965 reforms had no effect on the behavior of the residual.

[28]Michael Bruno, "Estimation of Factor Contribution to Growth," p. 364.

the part of entrepreneurs whereas Soviet enterprise directors are output maximizers. These two objectives are not mutually exclusive, however, and may produce identical behavior on the part of managers.[29] The extent of structural disequilibrium present in Soviet industry will be verified by testing several hypotheses against the data available on industrial wages, capital stock, labor and output. Chapter III contains the first of several such hypotheses and tests.

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[29]Edward Ames, Soviet Economic Processes (Homewood: Richard D. Irwin, Inc., 1965), p. 102. A full discussion of output maximizing models will be found in Chapter V.

CHAPTER III

STRUCTURAL DISEQUILIBRIUM: AGGREGATE ECONOMIC PERFORMANCE

Introduction

This chapter will examine the hypothesis of structural disequilibrium by fitting the CMS wage and production functions to postwar Soviet indexes of nonagricultural, nonresidential output, capital stock and labor. The data, drawn from Western sources, are contained in Appendix A. Originally it was hoped that the CMS function could be fitted to the prewar as well as the postwar period. But attempts to do so produced meaningless results, with high standard errors and negative estimates of the elasticity of output with respect to capital and technological progress. As an alternative attempts were made to fit a Cobb-Douglas production function over the prewar period; again the results were unsatisfactory. A CES specification attempted by John Whalley was equally unsatisfactory.[1] Whalley concluded that the "extreme structural change" during the prewar period precluded any growth description by an aggregate production function.[2] Although not made explicit by Whalley, the assumption of identical production functions

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[1] John Whalley, "Polish Postwar Economic Growth from the Viewpoint of Soviet Experience," Soviet Studies, XXIV (July, 1973), pp. 533-549.

[2] Ibid., p. 534.

for each sector within the aggregate, necessary for proper aggregation, was violated during the period of rapid structural change and probably accounted for the poor results.[3] Before proceeding to the empirical results, it is necessary to examine what may be expected from various production function specifications and to explain the methodology employed in determining the significance of the empirical results.

Forms of the Production Function

The two most frequently utilized production functions employed in the context of Soviet economic growth are the Cobb-Douglas and CES, whose most general specifications are given, respectively, in (1) and (2) below.

$$(1) \quad Y = AK^{\alpha}L^{\beta}$$

$$(2) \quad Y = A[\delta K^{-\rho} + (1-\delta)L^{-\rho}]^{-v/\rho}$$

where Y = output
K = capital
L = labor
α, β = share parameters for capital and labor respectively
A = scale parameter denoting the efficiency of technology
δ = an indication of the degree to which technology is capital intensive, $0 < \delta < 1$.

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[3] On this and other assumptions necessary in employing aggregate production functions to explain economic growth see M. Ishag Nadiri, "Some Approaches to the Theory and Measurement of Total Factor Productivity: A Survey," Journal of Economic Literature, VIII (December, 1970), pp. 1137-1177. Despite the problems of aggregation Weitzman, "Soviet Postwar Economic Growth," p. 676, concludes that "the aggregate approach may be one of the few useful ways of piecing together an overall account of economic growth."

v = the degree of returns to scale
$\rho = (1-\sigma)/\sigma$
σ = elasticity of substitution of labor for capital.

In most cases an exponential time trend is assumed, with A multiplied by the power term $e^{\lambda t}$, where λ = growth of technology. Furthermore, it is generally assumed that in (1) $\beta = 1-\alpha$ and in (2) $v = 1$. Thus both functions exhibit Hicks neutral disembodied technical change and constant returns to scale.[4]

Letting g_i represent the rates of growth of Y, A, K and L in the above functions, the growth of output (g_y) may be generally described in both by[5]

$$(3) \qquad g_y = g_a + \eta_k g_k + \eta_l g_l$$

where η_k, η_l = imputed competitively determined output shares of capital and labor respectively

$\eta_k + \eta_l = 1$, if constant returns to scale are assumed.

In (3), so long as $g_k \cong g_l$ then η_k and η_l will be roughly constant, as will the capital-labor ratios, and the Cobb-Douglas function (with σ constrained to one) will offer a reasonable explanation of g_y. This is so because the

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[4]For a description and comparison of these two production functions see Murray Brown, On the Theory and Measurement of Technological Change, Chapters 2 and 3. In both (1) and (2) time subscripts are implicit but have been omitted to simplify the notation.

[5]The following discussion is drawn from Weitzman, "Soviet Postwar Economic Growth," pp. 678-79. A general notational form for both (1) and (2) is $Y(t) = A(t)F[K(t), L(t)]$. To derive (3) differentiate this function with respect to time and divide by Y.

"elasticity of substitution effect" is negligible. Any decline in g_y will be attributed to a decline in total factor productivity (g_a) or, if g_k and g_l are declining, a declining g_y may be attributed to declines in the rate of growth of inputs. Both explanations of the decline in g_y over the postwar period are frequent in the Western literature on Soviet growth.[6]

If, however, $g_k \neq g_l$ (for the postwar period Western data shows an average annual increase in capital of 10.3 per cent and in labor of 2.5 per cent), the growth of output will become much more sensitive to the value of the elasticity of substitution because of the changing capital-labor ratio.[7] As Weitzman demonstrates

> so long as the elasticity of substitution were less than unity, the condition $g_k > g_l$ would imply that η_l would increase over time and η_k would decline. It follows that g_y would tend to decline over time due to the increasingly heavy weight of the slower g_l.[8]

In a situation where g_k greatly exceeds g_l, the elasticity of substitution effect is substantial and the Cobb-Douglas function fails, a priori, to offer a reasonable growth explanation. Weitzman finds the CES specification a more plausible rationalization of the postwar Soviet growth

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[6] See Chapter I for references citing these various points of view.

[7] This conclusion was derived by Richard R. Nelson in "The CES Production Function and Economic Growth Projections," Review of Economics and Statistics, 47 (August, 1965), pp. 326-27, as is the phrase "elasticity of substitution effect."

[8] Weitzman, "Soviet Postwar Economic Growth," p. 679.

experience.

However, the CES specification still constrains the elasticity of substitution to a constant, though not necessarily to one, over the period examined. Yet an examination of the data reveals a narrowing of the disparity between g_k and g_l.[9] Because of this, the CES specification may be valid only for the early postwar period; Soviet industry may be becoming more and more "Cobb-Douglas" over time. The CMS function "can be looked upon as a weighted sum (or difference) of Cobb-Douglas and a constant-proportions production function."[10] A priori, it may be expected that the CMS function will yield an elasticity of substitution between one (Cobb-Douglas) and whatever value is determined by the CES function over the same time period. And because the CMS function has as its asymptote, the Cobb-Douglas function, both the value of the elasticity of substitution and the imputed factor shares should approach one and the "usual" shares, respectively, over time.

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[9]For example, in 1960-61 g_k = 11.58 per cent and g_l = -0.5 per cent. By 1971-72 g_k = 7.9 percent and g_l = 2.6 per cent.

[10]Bruno, "Estimation of Factor Contribution," p. 362.

Statistical Procedures

The functional relationships to be subjected to empirical testing were derived in Chapter II and are

$$(4) \qquad Q/L = cw + d$$

$$(5) \qquad Q = Ae^{\lambda t}K^{\alpha}L^{1-\alpha} - mL$$

$$(6) \qquad \partial Q/\partial L = pw + q.$$

Equations (4) and (5) cannot be estimated in reduced form because of simultaneous equations bias due, in this instance, to the fact that wages affect costs of production and hence the price of output. As an alternative, they may be estimated independently and the unobservable marginal conditions (Equation (6)) obtained through the following transformations:

$$(7) \qquad p = (1-\alpha)c$$

$$(8) \qquad q = (1-\alpha)d - \alpha m.$$

In order to approximate confidence intervals for p and q, the upper and lower confidence bounds for c, d and α calculated from (4) and (5) will be inserted into (7) and (8). This operation will not, of course, produce true confidence intervals. But "if anything these bounds are probably biased in an outward direction, since this computation implicitly assumed full correlation between the component parameters . . ."[11]

Equation (4) lends itself readily to ordinary least squares regression techniques. But the nonlinear nature

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[11] Ibid., p. 367.

of equation (5) makes it necessary to employ one of two estimation techniques: logarithmic transformation and Marquardt's compromise.[12] In the original CMS article, Bruno employed Marquardt's compromise. However, it is possible to reproduce his results with the linearization formula to be presented below and there seems to be little need to employ a more complicated technique. This is especially so since neither method will produce true confidence limits for the parameter m.

First, equation (5) is linearized by the following transformation:

$$(5a)\quad \log(Q+mL) = \log A+\lambda t+\alpha \log K + (1-\alpha)\log L.$$

Due to the difficulties in separating time and scale effects with a small number of observations, (5a) is restricted to constant returns to scale:

$$(5b)\quad \log(Q/L+m) = \log A+\lambda t+\alpha \log (K/L).$$

Equation (5b) may then be estimated, given that the parameters are linear in the logs, the error term is multiplicative, and the ordinary least squares assumptions hold, by

$$(5c)\quad \log (Q/L+m) = \beta_0 + \beta_1 t + \beta_2 \log (K/L) + \log u.$$

In (5c) the value of m is unknown and must be fitted by trial and error. There is no *a priori* method of determining the possible range of m so a range $0 < m < 1$ was chosen.[13]

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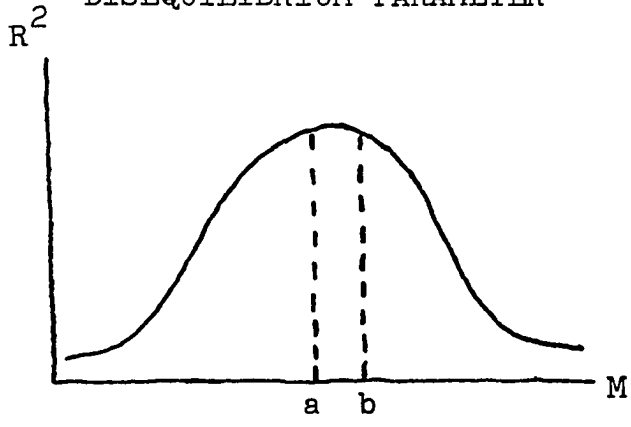
[12] N. R. Draper and H. Smith, *Applied Regression Analysis* (New York: John Wiley & Sons, Inc., 1966), p. 267.

[13] This range allows for the possibility that all additional labor acquired during a given year contributes nothing to output increases. See Chapter V for a fuller explanation of this phenomenon.

Using a scanning technique developed by Mayor,[14] all whole integer values of m within the specified range were inserted into (5c) and a plot of the values of the coefficient of determination (R^2) against m was used to narrow the range as below:

FIGURE 3

SCANNING TECHNIQUE FOR ESTIMATING DISEQUILIBRIUM PARAMETER



Once a peak range, ab, is determined, successively finer scans are run over this range at first one and then two decimals until no further increases in R^2 are produced by finer scans. This procedure is akin to the Marquardt compromise in which initial parameter values are specified and an iterative procedure minimizes the total sum of squares.[15]

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[14] Thomas H. Mayor, "Equipment Expenditures by Input-Output Industries," Review of Economics and Statistics, LIII (February, 1971), pp. 27.

[15] D. W. Marquardt, "An Algorithm for Least Squares Estimation of Non-Linear Parameters," Journal of Society of Industrial and Applied Mathematics, II (June, 1963), pp. 431-41.

Because the value of $\underline{m}$ obtained in this manner cannot itself be subjected tc significance tests, some method must be devised to allay the suspicion that even if the CMS function shows evidence of structural disequilibrium resulting in a production frontier shortfall ($m > 0$), the parameter may not be statistically significant. To do this, $\underline{m}$ is constrained to a value of zero, thereby reducing the CMS function to Cobb-Douglas, and (5c) is again fitted to the data. When $\underline{m}$ is constrained to zero then the elasticity of substitution is constrained to a value of one; hence, $m = 0$ will be considered the more restrictive hypothesis.

Weitzman suggests that a test statistic for the more restrictive hypothesis is:

> . . . the percentage increase in the error sum of squares . . . after reminimization under the more restrictive hypothesis. This statistic will be asymptotically distributed as an F-statistic when the sample size is sufficiently large.[16]

To see this, let the error sum of squares calculated for the CMS function be ESS_{cms} and the error sum of squares for the more restrictive Cobb-Douglas function be ESS_{cd}. In this case, the statistic $\psi \equiv (n-k)(ESS_{cd} - ESS_{cms})/ESS_{cms}$ will be distributed as an F-statistic with (1, n-k) degrees of freedom.[17] In this manner the CMS function is tested

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[16] Weitzman, "Soviet Postwar Economic Growth," p. 682.

[17] Ibid., p. 683. The number of observations is designated by $\underline{n}$; the number of parameters to be estimated by $\underline{k}$.

indirectly by comparison with the Cobb-Douglas function rather than directly by establishing significance levels for $\underline{m}$. The more restricted hypothesis is not rejected if it is below the upper confidence level of $F_{1,n-k}$.

Hypotheses and Tests

Two basic hypotheses are to be tested in this section:

Hypothesis 1: Wages are not proportional to marginal productivities, i.e., in equation (6) $p \neq 1$ and $q \neq 0$,

Hypothesis 2: Utilization of the factors of production is sub-optimal, leading to a shortfall from the production frontier, i.e., in equation (5) $m > 0$.

Fitting equation (4) by ordinary least squares yields[18]

$$c = 0.970 \qquad d = -1.73918$$

$$\begin{bmatrix} 0.989 \\ 0.951 \end{bmatrix} \qquad \begin{bmatrix} -1.80385 \\ -1.67451 \end{bmatrix}$$

$$R^2 = .99455 \qquad \text{D.W.} = .91315 .$$

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[18] The figures in brackets are upper and lower confidence bounds, derived by moving one standard error in each direction. Throughout confidence intervals will be given for all parameters utilized in equations (7) and (8) as well as for those necessary for the calculation of the elasticity of substitution. Also throughout R^2 = coefficient of determination adjusted for degrees of freedom and D.W. = Durbin-Watson statistic. The low D.W. values are often encountered in nonlinear equations and are, in such cases, not sufficient evidence to indicate autocorrelation. In equation (4) the wage index has been divided by 100 to avoid extremely small values for c. Since this is a linear transformation, it will not affect the estimated values of $\underline{c}$.

The search for an optimal value of $\underline{m}$ in (5c) yielded the following parameter estimates:

$$A = 1.01 \qquad \lambda = 0.02951$$

$$\begin{bmatrix} 1.033 \\ 0.987 \end{bmatrix} \qquad \begin{bmatrix} 0.04564 \\ 0.01248 \end{bmatrix}$$

$$\alpha = 0.27521 \qquad m = 0.27$$

$$\begin{bmatrix} 0.46842 \\ 0.08200 \end{bmatrix} \qquad R^2 = 0.9902$$

$$D.W. = 0.44391 .$$

From identities (7) and (8), the unobservable parameters of the marginal product of labor are:

$$p = 0.703 \qquad q = -1.33485$$

$$\begin{bmatrix} 0.873 \\ 0.526 \end{bmatrix} \qquad \begin{bmatrix} -1.08536 \\ -1.55934 \end{bmatrix} .$$

On the basis of these results hypothesis one, that wages are not proportional to marginal productivities, cannot be rejected as $\underline{q}$ is significantly different from zero. With $q < 0$ there is a positive differential between marginal productivity and wage rates, which would be expected if Soviet managers do indeed act as suggested in Chapter II. The associated value of $\underline{p}$ is a puzzling feature throughout these tests. When $p \neq 1$, an imperfectly competitive labor market is implied; $p < 1$ implies an element of monopsonistic behavior in the labor market. It may be that because of internal restrictions on the mobility of workers, elements of regional monopsonistic behavior show up in the aggregate wage figures. Evidence on this is scarce, but it is well known that many specific areas of the Soviet Union still experience labor surpluses and this phenomenon may be the

cause of the value of p. Given the pitfalls in aggregating heterogeneous labor services, one would hesitate to make a strong case for this however.

Applying formulas (8) and (10a-c) in Chapter II yields the following estimates of total factor productivity, factor shares and the elasticity of substitution:

Total Factor Productivity = 0.0348

Capital Share = 0.3245

Labor Share = 0.6755

Elasticity of Substitution = 0.9505 .

The factor shares are remarkably close to the "usual" Cobb-Douglas shares and, in fact, the elasticity of substitution is not significantly different from one. However, even in light of the above parameter values, the second hypothesis is rejected when m is constrained to zero.[19]

An examination of Table 13 provides additional insight into the acceptance of the second hypothesis. Values of the elasticity of substitution, ranging from 0.8887 to 0.9544 are never significantly different from one. Factor shares appear remarkably stable over this period and only slight decreases in total factor productivity are recorded.

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[19] With m constrained to zero, the estimated Cobb-Douglas function was $Q = 0.85e^{0.045}K^{0.22}L^{0.78}$. After performing the F-test described above, the hypothesis that this specification is the "true" one was rejected at the .95 per cent confidence level.

TABLE 13

VALUES OF TOTAL FACTOR PRODUCTIVITY, FACTOR SHARES AND THE ELASTICITY OF SUBSTITUTION DERIVED FROM WESTERN DATA, 1950-1966, PER CENT.

Year	Total Factor Productivity	Capital Share	Labor Share	σ
1950	3.816	64.4	35.6	.8887
1951	3.75	65.0	35.0	.8969
1952	3.72	65.3	34.7	.9012
1953	3.68	65.7	34.3	.9068
1954	3.64	66.1	33.9	.9116
1955	3.58	66.6	33.4	.9190
1956	3.52	67.2	32.8	.9265
1957	3.48	67.5	32.5	.9316
1958	3.45	67.8	32.2	.9352
1959	3.42	68.1	31.9	.9394
1960	3.39	68.4	31.6	.9435
1961	3.36	68.7	31.3	.9474
1962	3.35	68.8	31.2	.9493
1963	3.33	68.9	31.1	.9507
1964	3.33	69.0	31.0	.9516
1965	3.32	69.1	30.9	.9528
1966	3.31	69.2	30.8	.9544

Source: Calculated by applying equations (8), (9) and (10a-c) to the parameter estimates on pages 61-62.

However, because of the early base year (1937 = 100) used in Appendix A, these results are to be expected. To see this, consider the formulas for the elasticity of substitution and the labor share:

$$(6) \quad \sigma = 1 - (\alpha m/1-\alpha)1/y$$

$$(7) \quad E_1 = 1- \alpha(1+m/y).$$

In (6), as $y \to \infty$, $\sigma \to 1$ either from above or below depending on whether m is less than or greater than zero. Similarly, as $y \to \infty$ in equation (7), the term $(1+m/y) \to 1$ and the

labor share approaches 1- α. The familiar problem of index number relativity is not the cause of these results. Rather, it appears that like the Kementa approximation used in the estimation of the CES production function, parameter estimates are not insensitive to the units of measurement in the CMS specification.[20]

Conclusions

This chapter has utilized Western data sources on Soviet nonagricultural, nonservice production, capital stock, labor and wages in estimating a CMS production function for the postwar period. The hypothesis of the existence of structural disequilibrium was accepted, as was the hypothesis that the existence of structural disequilibrium resulted in a statistically significant shortfall from the production frontier.[21] The hypothesis that a Cobb-Douglas production function specification was the "true" functional form was rejected.

In addition to the estimation problems mentioned above, the high degree of aggregation--indexes include

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[20] J. Kementa, "On the Estimation of CES Production Functions," International Economic Review, 8 (June, 1967), p. 180.

[21] It should be made explicit that the parameter m measures the shortfall due to structural disequilibrium and not the total shortfall from the production frontier. Organization impacts preclude the establishment of "the" production frontier. On this see Earl R. Brubaker, "A Sectoral Analysis of Efficiency Under Plan and Market," Soviet Studies, XXIII (January, 1972), p. 435.

construction, transportation, communications and distribution as well as industry--does not allow a clear picture of the behavior of Soviet industry. Inclusion of the distributive sector is especially troubling in light of the poor performance of this sector vis-a-vis other nonagricultural, nonservice sectors.[22] In an attempt to overcome many of these problems, Chapter IV will provide estimates of the CMS function at a lower level of aggregation (industry only), utilize direct Soviet sources and employ a later base year (1960 = 100).

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[22] Ibid., p. 443.

CHAPTER IV

STRUCTURAL DISEQUILIBRIUM: INDUSTRY PERFORMANCE

Introduction

This chapter will examine the structural disequilibrium hypothesis by fitting the CMS wage and production functions to postwar Soviet industry. This chapter differs in several respects from Chapter III. First, the tests are performed at a lower level of aggregation, with construction, transportation, communications and distribution now excluded from the indexes. Second, direct Soviet sources will be relied upon rather than Western reconstructions and the indexes are extended through 1972. Third, two sets of gross output indexes will be employed--one using Western value-added weights, the other using Soviet value-added weights. Finally, 1960 rather than the 1937 base year is used. Implicit in this is the use of postwar rather than prewar price weights. In order to determine the possible effects of these changes, each will be examined more fully.

By operating at a lower level of aggregation, it is expected that the extent of structural disequilibrium will be less. Industry remains the most important single sector in the economy of the USSR and one would expect performance to reflect this. There is also evidence that

since the middle 1960's the Soviets have succeeded to a certain degree in stemming the extent of wage inflation, freezing and, in some cases, lowering the wages of highly paid personnel.[1] Finally, the industrial reforms of 1965, which would not have been in evidence in indexes extending only through 1966, have undoubtedly had some effect on the efficiency with which resources have been utilized. Some very indirect evidence on the performance of industry vis-a-vis other sectors is presented in Table 14.

TABLE 14

SOVIET OUTPUT PER MAN-HOUR BY SECTOR, 1964
(RESPECTIVE WESTERN COUNTRIES = 100)

	Sector			
Country	Industry	Construction	Transportation and Communications	Commerce
West Germany		117[a]		62[b]
United Kingdom	136	188	104	126
France	83	164	113	78
Italy		164[a]		69[b]

[a]Pertains to Industry and Construction combined.

[b]Pertains to Transport and Communication, Commerce, and Services combined.

Source: Earl R. Brubaker, "A Sectoral Analysis of Efficiency Under Market and Plan," Soviet Studies, XXIII (January, 1972, p. 443.

[1]Kirsch, Soviet Wages, p. 172, 184.

Industrial output per man-hour is generally higher than for other sectors relative to the Western countries studied. While this performance index will be affected by many things such as the quantity and quality of the capital stock, the skill level of the labor force, and others, it is not unreasonable to expect that the generally higher output per man-hour in industry is also partly due to a more efficient use of resources.

Soviet data, while still suspect, have shown considerable improvement both with respect to quantity and quality since the middle 1950's. Soviet indexes of industrial output continue to show faster rates of growth than Western reconstructions; explanations of capital stock data are inadequate and organizational changes in industry have made necessary numerous modifications of Soviet man-hour and wage data. But the use of postwar price bases in current handbooks has greatly reduced the problem of index number relativity and Soviet data can now be utilized directly, albeit with considerable caution.[2] Figure 4 illustrates the slightly higher growth rates of the Soviet indexes.

In constructing an index of industrial output, two sets of gross value-added weights were used and the disparity between them is illustrated in Figure 5. The principal difference between these two indexes is the

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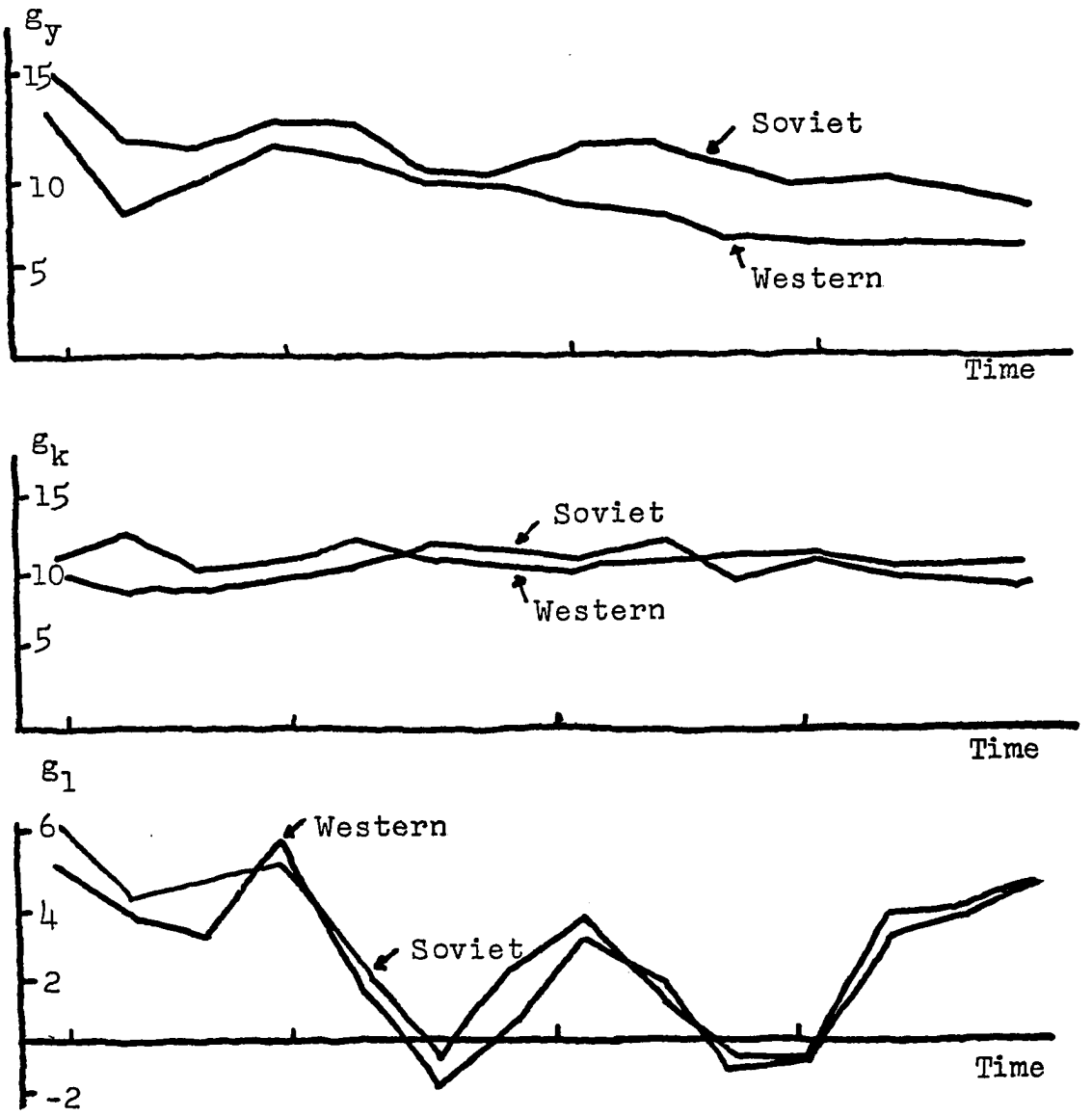
[2]A detailed criticism of Soviet data may be found in Appendix B.

FIGURE 4

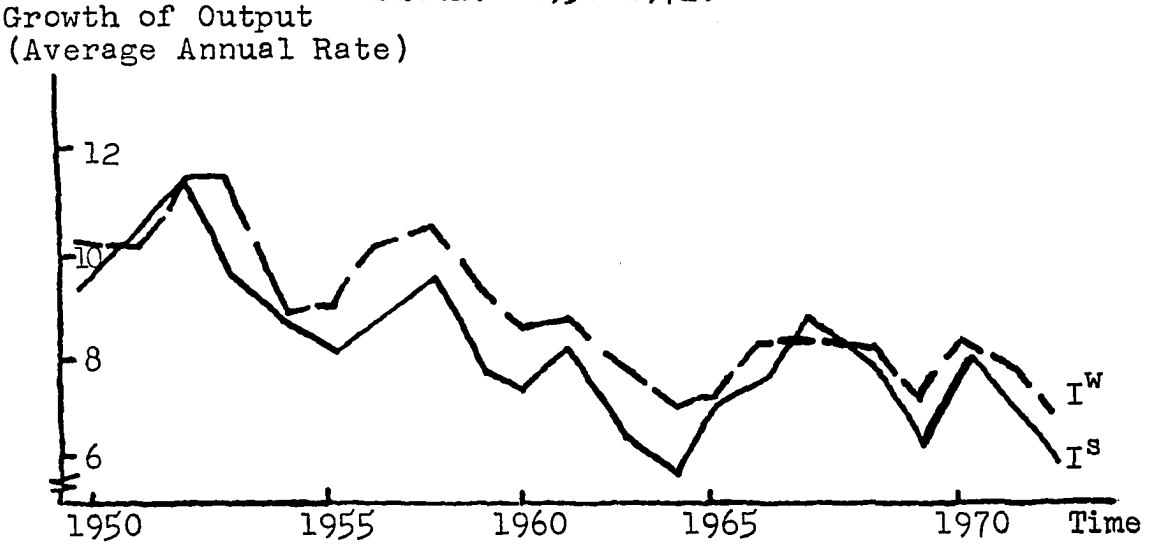
COMPARATIVE GROWTH RATES OF WESTERN AND SOVIET INDEXES OF OUTPUT (g_y), CAPITAL STOCK (g_k) AND LABOR (g_l): 1950-70.



Source: Appendix B, Table 2; Rush V. Greenslade, "Industrial Production Statistics in the USSR," in Soviet Economic Statistics, ed. by Vladimir G. Treml and John P. Hardt (Durham: Duke University Press, 1972), pp. 158-59.

FIGURE 5

A COMPARISON OF THE GROWTH OF SOVIET OUTPUT INDEXES ASSUMING UNIFORM AND DIFFERENTIAL RATES OF RETURN ON THE SOVIET CAPITAL STOCK: 1950-1972.



Source: Appendix B, Table 2.

result of slightly different capital charges. The index labeled I^W was constructed on the assumption that the industrial capital stock earned a ten per cent rate of return; hence, the capital charge for each sector consists of ten per cent of the value of the gross capital stock plus amatorization charges as taken from Soviet handbooks. The assumptions implicit in this are that Soviet amatorization rates reflect the true rates of physical and technological obsolescence and that investment is allocated in such a manner as to eliminate differential rates of return. The index I^S draws directly on Soviet profit data to obtain capital charges, resulting in differential capital charges

among the industrial sectors. Such a procedure is valid if it can be assumed that the differential charges do not reflect differential risk among the sectors, probably a legitimate assumption in a centrally planned economy.[3] The two methods yield different sectoral rates of return, as shown in Table 15.

TABLE 15

RATES OF RETURN ON SOVIET CAPITAL STOCK, BY SECTOR, 1960

Sector	R_I^W	R_I^S	Sector	R_I^W	R_I^S
Electricity	12.60	13.71	Chemicals	13.54	19.67
Fuels	16.59	8.79	Glass and Ceramics	13.80	31.85
Ferrous Metals	13.51	13.42	Machine Building*	13.71	18.05
Nonferrous Metals	13.51	16.76	Light Industry	13.60	34.44
Wood and Paper	15.83	17.00	Food Industry	13.64	23.78
Construction	14.45	10.34	Industry Average	14.17	17.66

*Includes Metal Working

Source: Weitzman, "Soviet Postwar Economic Growth," p. 689; Thornton, "Differential Capital Charges," p. 554.

Changing the base year from 1937 to 1960 will affect the growth rates of industrial output only if there has been a marked structural change over this period or if relative prices have changed dramatically. Structurally, the Soviet economy is little changed since 1937 and, although there have been frequent price reforms, relative

[3] Thornton, "Differential Capital Charges," p. 558.

prices have not been altered dramatically. In the absence of such changes, the two output indexes will be virtually the same.

Hypotheses and Tests

As in Chapter III, two basic hypotheses are to be tested:

Hypothesis One: Wages are not proportional to marginal productivities.

Hypothesis Two: Utilization of the factors of production is sub-optimal, leading to a shortfall from the production frontier.

Beginning with the GVO indexes aggregated on the assumption of an industry-wide ten per cent rate of return on capital, the parameters of the average wage equation are:

$c = 2.019$ $\quad$ $d = -1.0745$

$$\begin{bmatrix} 2.090 \\ 1.948 \end{bmatrix} \qquad \begin{bmatrix} -0.9958 \\ -1.1532 \end{bmatrix}$$

$R^2 = 0.9731$ $\quad$ D.W. = 0.1778

The parameters of the resulting CMS production function are:

$A = 1.008$ $\quad$ $\lambda = 0.01084$

$$\begin{bmatrix} 1.013 \\ 1.003 \end{bmatrix} \qquad \begin{bmatrix} 0.01493 \\ 0.00675 \end{bmatrix}$$

$\alpha = 0.58534$ $\quad$ $m = 0.24$

$$\begin{bmatrix} 0.63572 \\ 0.53396 \end{bmatrix}$$

$R^2 = 0.9988$
D.W. = 0.4790

Through the previously established identities, the parameters of the marginal product of labor equation are:

$$p = 0.8371 \qquad q = -0.586$$

$$\begin{bmatrix} 0.9409 \\ 0.7355 \end{bmatrix} \qquad \begin{bmatrix} -0.544 \\ -0.629 \end{bmatrix}$$

As q is significantly different from zero, the hypothesis that wages are not proportional to marginal productivities is accepted. Evidence of monopsonistic elements within the labor market are suggested by the value of p, which is less than one.

Turning to the significance of the parameter m, the elasticity of substitution was forced to one and the production function re-estimated. The resulting increase in the error sum of squares was 337 per cent; the hypothesis that the Cobb-Douglas function was the true functional form was rejected at the .95 per cent confidence level. The second hypothesis was not rejected; the CMS function shows evidence of a statistically significant shortfall from the production frontier resulting from the existence of structural disequilibrium in the factor markets.

Over the postwar period, the elasticity of substitution was estimated to be 0.6892, a value significantly less than one. Total factor productivity grew at a rate of 1.32 per cent per annum and factor shares were distinctly "untypical"--28.59 and 71.41 per cent for labor and capital respectively. The movement of these parameters over the postwar period is shown in Table 16. Somewhat alarming is the extent to which factor shares and the elasticity of substitution vary. For example, in 1950 a ten per cent

increase in the capital stock would bring forth an output increase of over nine per cent whereas a similar increase in labor would result in an output increase of less than one per cent. By 1972, ten per cent increases in capital and labor would bring forth 6.55 and 3.45 per cent increases in output respectively.

TABLE 16

VALUES OF TOTAL FACTOR PRODUCTIVITY, FACTOR SHARES AND THE ELASTICITY OF SUBSTITUTION DERIVED FROM SOVIET DATA, 1950-1972, PER CENT.

Year	Total Factor Productivity	Capital Share	Labor Share	σ
1950	1.71	92.4	7.6	.1836
1951	1.66	89.6	10.4	.2504
1952	1.62	87.4	12.6	.3029
1953	1.59	85.7	14.3	.3459
1954	1.55	83.7	16.3	.3928
1955	1.50	81.3	18.7	.4519
1956	1.46	78.9	21.1	.5083
1957	1.43	77.1	22.9	.5519
1958	1.40	75.7	24.3	.5868
1959	1.37	74.1	25.9	.6236
1960	1.34	72.6	27.4	.6612
1961	1.32	71.3	28.7	.6920
1962	1.31	70.5	29.5	.7104
1963	1.29	69.9	30.1	.7252
1964	1.29	69.5	30.5	.7349
1965	1.28	69.1	30.9	.7447
1966	1.27	68.5	31.5	.7594
1967	1.26	67.9	32.1	.7741
1968	1.25	67.4	32.6	.7854
1969	1.25	67.7	32.3	.7801
1970	1.23	66.4	33.6	.8105
1971	1.23	65.9	34.1	.8231
1972	1.21	65.5	34.5	.8316

Source: Calculated by applying equations (8), (9) and (10a-c) to the parameter values given on pages 72-73.

As was demonstrated above, the rate of growth of factor shares is related to the value of the elasticity of substitution which, in this case, grew rapidly during the early 1950's.[4] Rather than being a statistical anomoly, the results shown in Table 16 likely reflect the fact that postwar reconstruction was not completed until the middle 1950's. During such a period, output responds very quickly and dramatically to the refurbishing of partially destroyed capital stock.

In order to determine what effect the use of Soviet GVO weights might have on the parameter estimates, the CMS model was re-estimated using the output series in Table 2, Appendix B. The results were similar to those already examined. Again the disequilibrium parameter (q) was significantly different from zero and a 387 per cent increase in the error sum of squares resulted from constraining the elasticity of substitution to one. On the basis of these results, neither hypothesis could be rejected.[5]

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[4] See equation (8), p. 44 above.

[5] The parameters and their respective confidence intervals are:

$$c = \underset{\begin{bmatrix}1.860\\1.728\end{bmatrix}}{1.794} \qquad d = \underset{\begin{bmatrix}-0.7852\\-0.9306\end{bmatrix}}{-0.8579} \qquad \alpha = \underset{\begin{bmatrix}0.4135\\0.3071\end{bmatrix}}{0.3603} \qquad \lambda = \underset{\begin{bmatrix}0.01908\\0.01062\end{bmatrix}}{0.01485}$$

$$p = \underset{\begin{bmatrix}1.197\\1.091\end{bmatrix}}{1.148} \qquad q = \underset{\begin{bmatrix}-0.7861\\-0.6507\end{bmatrix}}{-0.7146} \qquad \sigma = \underset{\begin{bmatrix}0.8094\\0.6969\end{bmatrix}}{0.7579} \qquad A = \underset{\begin{bmatrix}1.28\\1.16\end{bmatrix}}{1.22}$$

$$m = 0.46 \qquad E_1 = 48.49 \qquad E_2 = 51.51.$$

Factor shares, however, show much more stability in the postwar period when Soviet GVO weights are used. As Table 17 illustrates, the labor share rose from 26.4 to 55.1 per cent while the capital share fell from 73.6 to 44.9 per cent. These results are partially due to the

TABLE 17

VALUES OF TOTAL FACTOR PRODUCTIVITY, FACTOR SHARES AND THE ELASTICITY OF SUBSTITUTION DERIVED FROM SOVIET GVO WEIGHTS, 1950-1972, PER CENT.

Year	Total Factor Productivity	Capital Share	Labor Share	σ
1950	3.03	73.6	26.4	.4127
1951	2.90	70.3	29.7	.4649
1952	2.81	68.1	31.9	.4981
1953	2.72	66.0	34.0	.5308
1954	2.63	63.9	36.1	.5640
1955	2.54	61.7	38.3	.5991
1956	2.44	59.1	40.9	.6393
1957	2.36	57.2	42.8	.6688
1958	2.30	55.8	44.2	.6902
1959	2.22	53.9	46.1	.7206
1960	2.17	52.6	47.4	.7410
1961	2.11	51.2	48.8	.7624
1962	2.08	50.4	49.6	.7748
1963	2.06	49.9	50.1	.7833
1964	2.04	49.6	50.4	.7881
1965	2.02	49.1	50.9	.7954
1966	1.99	48.4	51.6	.8067
1967	1.96	47.6	52.4	.8185
1968	1.94	47.1	52.9	.8274
1969	1.92	46.6	53.4	.8352
1970	1.89	45.8	54.2	.8465
1971	1.86	45.2	54.8	.8560
1972	1.85	44.9	55.1	.8616

Source: Calculated by applying equations (8), (9) and (10a-c) to the parameter values given on page 56, note 5.

Soviet GVO weights which, because of the high weights attached to the relatively slowly growing light and food industries, result in a slightly slower growth of industrial output. But the results also establish some credibility for the use of Soviet profit data which, as Table 14 demonstrates, show remarkably high rates of return on capital in the light and food industries. Both the persistent sellers market and the relatively high turnover taxes in evidence in the consumers' goods industries would lead one to expect this. Soviet profit accounting procedures, however, also contributed to these high profit levels. In cost-plus pricing, profits are relatively highest in those industries that are relatively under-capitalized.[6]

Great caution should be exercised in explanations of the fluctuations in factor shares. Methods for breaking down the components contributing to output growth are still crude and leave a great many factors unaccounted for which are known to affect output.[7] The validity of the Solow method requires the assumption of constant returns to scale and neutral technological change. Furthermore, the Solow method confounds "changes in the composition of output and

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[6]A more complete discussion of this in relation to the USSR may be found in Alec Nove, The Soviet Economy (New York: Frederick A. Praeger, Publishers, 1969), p. 249.

[7]The method used here is that derived by Robert M. Solow, "Technical Change and the Aggregate Production Function," Review of Economics and Statistics, XXXIX (August, 1957), pp. 312-320.

and changes in the production function."[8] The difficulty which arises is that

> if the economy utilized more intensively sectors which boast comparative advantages, the overall productivity measure would increase even though each individual sector's production function may have remained unchanged.[9]

These difficulties are inherent in all aggregate production functions, but they should be kept in mind when examining the above results. Nevertheless, the factor shares derived above appear reasonable in light of Soviet estimates of aggregate production functions.

Soviet Production Function Estimates

It is instructive to compare the above results with those obtained by Soviet economists who have estimated aggregate production functions. The use of aggregate functions is not widespread among Soviet economists, but three such studies have been published. The Mikhalevsky-Solov'ev study is the most widely known.[10] The authors fitted the following function for the total economy over the period 1951-1963:

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[8] Brown, Technological Change, p. 105.

[9] Ibid., p. 105.

[10] B. N. Mikhalevsky and Ju. P. Solov'ev, "Proizvodectvennaia funktsiia narodnovo khoziaistva SSSR v 1951-1963 gg," Ekonomika i matematicheskie metody, 6 (1966), pp. 823-840. The above discussion is drawn from Joseph Berliner, "The Mikhalevsky-Solov'ev Production Function, USSR 1951-1963: An Exposition for Discussion," November, 1963, mimeographed.

$$Y_t = \delta(L^{\alpha 1t} K^{\alpha 2t} R^{\alpha 3t} e^{\Sigma \pi_\theta})^{\psi t} \mu_t$$

where Y_t = final product (national income)
L_t = man-hours of labor, adjusted for quality
K_t = capital stock, with embodied technological progress
α_{it} = elasticities of output with respect to factor i;
R_t = land at market value (?)
δ = parameter of neutral effectiveness
π = rate of autonomous technological progress
ψ_t = gross scale factor
μ_t = error term

From this function, the following factor shares were obtained: labor, 54.12 per cent; capital, 33.40 per cent; land, 12.48 per cent. The elasticity of substitution of labor for capital was found to be 1.197. A. Tolkacheb estimated the following function for industry over the period 1950-1964:[11]

$$Q = AX^{\alpha} Y^{\beta}$$

where A = neutral shift parameter
Q = net industrial product
X = labor time expenditures
Y = production fund in (current?) rubles
α, β = elasticities of output with respect to X and Y.

The resulting estimate was:

$$Q = 1.186\ X^{0.155}\ Y^{0.845}.$$

No explanation of the data used was given nor were other parameter estimates supplied; consequently, it was impossible to determine the elasticity of substitution. A similar production function by B. I. Iskakov, et. al.,

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[11] A. Tolkacheb, "Ob effektivnosti obshchestvennogo proizvodstva," Planovoe khoziaistvo, 6 (June, 1966), p. 3.

in which the dependent variable was national income, yielded:[12]

$$Q = 1.03\ K^{0.9}\ L^{0.1}.$$

In all of the above functions the elasticity of output with respect to labor is much lower than the "normal" Cobb-Douglas elasticities estimated for Western countries. In commenting on one of these functions, Peter Wiles notes that a possible explanation for the relatively low elasticity of output with respect to labor lies in the fact that the productivity of the marginal worker is considerably lower than that of the average worker, while the income of the marginal worker is little, if any, below that of the average worker. As a result, the use of income weights, especially Western income weights, tends to overstate the marginal productivity of labor, although Soviet income weights would involve relatively less overstatement.[13] Commenting further, Wiles notes that

> It would appear, in particular, that the notorious Soviet practice of wishing unwanted labour upon factories has shown up in Mr. Iskakov's figures. Amazing as these results are, I find them entirely plausible on deeper consideration.[14]

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[12]Cited in Peter Wiles, "Is the Soviet Agricultural Plan for 1966-1970 Reasonable?" in The Prediction of Communist Economic Performance, ed. by P. J. D. Wiles (Cambridge: Cambridge University Press, 1971), p. 336. The Soviet concept of national income is used in all of the above studies. As this concept omits the service sectors, which typically are labor intensive and show little productivity gains, it may partially explain the unusually low labor elasticities.

[13]Ibid., p. 334.

[14]Ibid., p. 336. Italics in original.

Judging from these production function estimates by Soviet economists, the factor elasticities shown in Tables 16 and 17 do not appear to give an unreasonable picture of the behavior of Soviet industry. It was the realization that output elasticities obtained from direct estimates of Soviet production functions were not typical of similar elasticities obtained for Western countries that prompted Hansen's criticism of the methodology of Berliner, Bergson, et. al. in determining the joint factor productivity of the USSR relative to the United States and Western Europe.[15]

Conclusions

This chapter has tested the structural disequilibrium hypothesis, utilizing direct Soviet data sources, at the industry level of aggregation. Two sets of GVO weights were employed, differing only with respect to the capital charge. The hypotheses of structural disequilibrium and production frontier shortfalls could not be rejected at the .95 per cent confidence level, irregardless of which capital charge was used. The elasticity of substitution was found to be less than one over the entire period; however, a year-by-year calculation of this parameter revealed that, as the disparity between the growth rates of capital and labor narrowed, the value of the parameter approached one.

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[15]Hansen, "East-West Comparisons," p. 337.

An analysis of factor shares over time revealed that the growth contribution of the capital input was considerably higher than could be expected from Western experience. This fact, coupled with only a slight decline in the rate of growth of total factor productivity over the postwar period, suggests that attributing the decline in industrial output growth to rapidly declining total factor productivity results from the use of Western income shares as weights rather than empirically determined output elasticities. In Chapter V, the implications of structural disequilibrium on future industrial growth will be explored and further comparisons between the CMS and alternative production functions will be made.

CHAPTER V

EFFICIENCY GAINS IN SOVIET INDUSTRY

Introduction

The empirical results of chapters three and four have verified the hypothesis of structural disequilibrium by demonstrating (1) that wages are not proportional to marginal productivities of labor and (2) that production is sub-optimal in that a redistribution of input usage according to the rule $P_i/MP_i = P_j/MP_j$ would produce output increases. These empirical results, however, run counter to two theoretical models of the Soviet firm and it is appropriate to discuss these models before proceeding further in the analysis of the structural disequilibrium hypothesis.[1]

Output-Maximizing Models of the Soviet Enterprise

The Ames model postulates a managerial utility function of the form

$$(1) \quad U = ax + (1-a)y,$$

[1] The two models, referred to throughout this section as the Ames model and the Portes model, are Edward Ames, Soviet Economic Processes (Homewood: Richard D. Irwin, Inc., 1965) and R. D. Portes, "The Enterprise under Central Planning," Review of Economic Studies, XXXVI (April, 1969), pp. 197-211. Only an outline presentation of these models will be given in this section. For a full presentation, including algebraic derivations, see the above sources.

where x = output, y = profits, U = utility, $0 \leqq a \leqq 1$, and a production function of the form

$$(2) \quad x = x(v_i \ldots . v_n),$$

where v = inputs, i = i...n. The enterprise managers are assumed to maximize output, subject to the constraint that revenues must equal costs, thus

$$(3) \quad G = x - \lambda(px - \Sigma w_i v_i),$$

where G = function to be maximized, λ = Lagrange multiplier, p = fixed price of output and w_i = cost of input i.

Relating G to changes in input usage produces, after appropriate substitution

$$(4) \quad \partial G/\partial i = \partial x/\partial v_i - \lambda(\partial y/\partial v_i) = 0.^2$$

Rearranging the terms of (4) yields

$$(5) \quad \frac{\lambda p - 1}{\lambda} = \frac{w_i}{\partial x/\partial v_i}.^3$$

In (5), the right-hand side is independent of i, thus the familiar input rule holds, i.e.,

$$(6) \quad \frac{w_i}{w_j} = \frac{\partial x/\partial v_i}{\partial x/\partial v_j}.$$

Because of (5), Ames is able to show that the output-maximizing enterprise subjected to a cost constraint will be a cost-minimizer and there will be no difference in the demand

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[2] Equation (4) may be derived from the profit equation, $y = px - \sum_{i=1}^{n} w_i v_i$, which will yield $\partial y/\partial v_i = p(\partial x/\partial v_i) - w_i$.

[3] Obtained by multiplying both sides of (4) by $\lambda p - 1$.

for inputs between profit-maximizing and output-maximizing enterprises.

The Portes model also assumes the enterprise is an output-maximizer, but that it operates under a constraint system slightly different from that postulated by Ames.[4] The production and cost functions, respectively, are

$$(7) \quad x = f(v) = f(y + z)$$

$$(8) \quad c(v) = ry + (r + t)z \ .$$

The profit function may then be written as

$$(9) \quad \pi(y,z) = qx - \Sigma c_i = qf(y + z) - [ry + (r + t)z] \ .$$

If the production function is strictly concave and twice differentiable, a positive profit level exists at some level of output, and all inputs are used in positive quantities, the enterprise will max $x = f(y + z)$, subject to $\Pi \geq P$. Such a maximum is feasible if there exist shadow prices $(\lambda, u_i \ldots u_n)$ such that

$$(10) \quad \partial f/\partial y_i + \lambda \partial \Pi/\partial y_i - u_i = 0, \ i = 1 \ldots n, \ y_i > 0$$

$$(11) \quad \partial f/\partial y_i + \lambda \partial \Pi/\partial z_i = 0, \ i = 1 \ldots n, \ z_i > 0.$$

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[4] The notation employed by Portes is:
v_i = inputs, $i = 1 \ldots z$
a_i = central input allocation to enterprise i
r_i = official fixed price of a_i
y_i = actual input usage of enterprise i
z_i = above-plan input usage by enterprise i
$[r_i + t_i(z_i)]$ = per unit price of z_i
x = output
q = fixed price of x
Π = actual profit
P = planned profit
$f(x)$ = production function
$v_i(c_i)$ = cost function.

When the central input allocations act as effective constraints for some inputs (i = 1...m) and not for others (i = m+1....n), then the first order maximizing conditions will be[5]

$$(12)\quad \partial\Pi/\partial v_i = \left\{\begin{array}{l} \partial\Pi/\partial z_i,\ i = 1...m \\ \\ \partial\Pi/\partial y_i,\ i = m+1...n \end{array}\right\} = qf_i - c_i',\ i = 1 = n.$$

$$(13)\quad \partial\Pi/\partial v_i < 0,\ i = 1...n$$

From equations (12) and (13) it can be seen that the marginal profitability of each input is negative if the equilibrium conditions hold. As a result, whenever some or all central input allocations are not effective constraints on the enterprise, the input rule becomes

$$(14)\quad c_i'/f_i = q + 1/\lambda \quad .$$

As in the Ames model, one side of (14) is free of i and the demand for inputs by the output-maximizing firm will be no different from that of a profit-maximizing firm, i.e., $c_i'/f_i = c_j'/f_j = q + 1/\lambda$.

Both Ames and Portes thus reach the same conclusion: the output-maximizing enterprise, if subjected to an effective constraint system, will be a cost-minimizer. Ames reaches this conclusion by a system of multiple pricing; Portes by a profit constraint. With respect to the output market, Ames again reaches the competitive solution,

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[5]Equation (12) may be derived by recognizing that $\partial\Pi/\partial y_i = qf_i - r_i$ and $\partial\Pi/\partial z_i = qf_i - (r_i + t_i = z_i t_i')$, i = 1...n. The prime (') and f_i both indicate first order partial derivatives.

with production carried out at the minimum point on the average cost curve. Portes, however, demonstrates that output will be greater in output-maximizing enterprises than in profit-maximizing enterprises. To show this, it is necessary to note that the marginal cost of output is

$$(15) \quad c'(x) = q + 1/\lambda > q.$$

Note that in (15) the profit constraint ($\Pi = P$), coupled with the cost-minimizing rule derived in (14), implies that planned profits may be treated as another cost. Rearranging (14) and substituting into (15) yields

$$(16) \quad c_i' = (q + 1/\lambda)f_i = C'f_i.$$

As (16) shows, for the output-maximizing firm, marginal cost exceeds price.

Critique of Output-Maximizing Models

The Ames and Portes models demonstrate that an enterprise operating in an environment of central planning may be made responsive to prices to the extent that the enterprise will minimize costs. Neither model, however, can demonstrate that this micro-efficiency behavior on the part of the enterprise will lead to "allocative efficiency" in terms of "optimal input combinations and optimal relative levels of output. . ."[6] To demonstrate allocative efficiency, one must assume that the centrally determined prices are themselves rational. While each enterprise may respond correctly to centrally determined input and output prices,

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[6]Portes, "The Enterprise under Central Planning," p. 203.

these prices may be such that structural disequilibrium still prevails.

Moreover, the output-maximizing behavior described above is a mis-specification of enterprise operations in an orthodox Soviet-type system of central planning for several reasons.[7] First, such enterprises do not maximize output. Second, the managerial utility functions are neither as simple as those described by Ames and Portes, nor are they devoid of a time dimension. Third, because of the multiple arguments contained in the managerial utility functions, the constraint systems cease to be effective. Although these are all inter-related, it is best to discuss each separately.

To assume that a Soviet-type enterprise maximizes output ignores the role of centrally determined output targets and the role of information in a centrally planned economy. The orthodox Soviet enterprise attempts to meet its planned output target and (as will be shown below) to slightly overfulfill it if possible. Whether the enterprise response to the centrally determined output target is optimal, that is, whether production occurs at the lowest point on the average cost curve, depends on the correctness of the information on plant capacity which the enterprise

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[7] A description of the micro-behavior of the Soviet enterprise may be found in David Granick, "The Orthodox Model of the Soviet-Type Firm Versus Romanian Experience," Working Paper No. 18, International Development Research Center, Bloomington, Indiana, September, 1972, pp. 2-3.

supplies the central planners and on the tautness of the output targets. For example, an enterprise manager may conceal his true plant capacity in order to secure an easily fulfilled output target, which would imply some underutilization of available resources.[8] Central planners may offset this enterprise behavior to some extent by making output targets as taut as possible. But the enterprise manager may counter this move by more intensively utilizing the most readily available production factor--labor. This process, known as "storming," occurs several times a year as enterprises attempt to meet quarterly plan targets.[9] One would expect the capital-labor ratio of an individual enterprise to rise throughout the quarterly planning period. In such a case, input usage responds not to relative prices, but to the tautness of output targets.

Considering the managerial utility function to be a timeless, increasing function of only output and profit ignores two aspects of the Soviet managerial bonus system. First, while bonuses are a substantial percentage of managerial income, virtually no bonus is received if the planned output targets are not fulfilled. Thus for any output below the planned targets, the only argument in the utility

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[8]For numerous examples of how Soviet managers conceal plant capacity see Berliner, Factory and Manager, Chapter VI.

[9]Alec Nove, "The Problem of 'Success Indicators' in Soviet Industry," Economica, N.S. XXV (February, 1958), pp. 1-13.

function is the output target. However, since the output target of the following year is determined by the actual production in the current year, an enterprise manager will seldom greatly overfulfill the plan. To do so would reveal true plant capacity and possibly jeopardize future bonuses.[10] Second, the manager has been presented with a number of plan targets which must enter his utility function. By itself this fact does not destroy the effectiveness of a simple utility function, since one may easily add a vector of arguments. However, the targets given the Soviet manager are often mutually exclusive, thereby forcing the manager to pick some targets which he will attempt to fulfill and others which he will ignore. Moreover, the priority in fulfilling targets is, in many cases, dependent on the political and economic situation of the given moment.

The multiple and often conflicting centrally determined targets combine to lessen the effectiveness of any given constraint on the enterprise manager.[11] The use of a profit constraint ignores the method of economic calculation prevailing in the Soviet Union. Planned profits are

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[10] Berliner, Factory and Manager, p. 77.

[11] Because each target carries with it a bonus for fulfillment, conflicting targets lead to conflicting monetary signals to the enterprise manager. For this reason, the 1965 reforms greatly reduced the number of plan targets. But a basic difficulty remained: enterprise managers still do not respond as the central planners wish, especially in the area of the quality and assortment of goods. On this see Nove, The Soviet Economy, Chapters 6 and 9.

based on average costs for a given industry. As a result, certain enterprises must operate at a planned loss while other, more efficient enterprises, obtain above-plan profits. In neither case is a planned profit constraint an effective one. In the same manner, a constraint requiring the enterprise to cover costs also becomes ineffective when planned-loss enterprises operate within an industry.

Thus the Ames-Portes models misspecify the behavior of the Soviet enterprise. And, as was pointed out earlier, even if these models were correctly specified, macro efficiency would depend upon the correctness of the prices set by the central authorities. There is little evidence to suggest that these centrally determined prices are based on rational economic calculations.[12] There is, however, one further consideration. Even if one could assume that centrally determined prices conformed to the rules of allocative efficiency, there is no assurance that enterprise managers would respond correctly to changes in relative prices. As Professor Bergson pointed out, monopoly power, product differentiation, uncertainty, multiproduct enterprises and externalities all may mitigate the efforts of central planners to induce managers to respond correctly

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[12]For a description of Soviet pricing practices see Morris Bornstein, "Soviet Price Theory and Policy," in New Directions in the Soviet Economy, Joint Economic Committee, United States Congress (Washington: U. S. Government Printing Office, 1966), Part 1, pp. 65-94.

to relative input prices.[13] For these reasons, the output-maximizing models of the Soviet enterprise do not offer convincing theoretical arguments against the existence of structural disequilibrium in the Soviet economy.

Production Potential Under Structural Disequilibrium

If, as the empirical evidence of the previous chapters indicates, the existence of structural disequilibrium results in a shortfall from the production frontier, it is appropriate to consider the opportunity cost associated with such a disequilibrium situation. Consider first the original specification of the CMS production function:

$$(1) \quad Q = Ae^{\lambda t}K^{\alpha}L^{1-\alpha} - mL.$$

In order to determine the costs of structural disequilibrium, it is necessary to explicitly include a time dimension in (1). To do so, rewrite (1) as

$$(2) \quad Q_i/Q_o = Ae^{\lambda t}(K_i/K_o)^{\alpha}(L_i/L_o)^{1-\alpha} - m(L_i/L_o),$$

where the subscript o = 1950 and i = 1951-1972.

When $m > 0$, it indicates the percentage of the increase in the labor force in a given year which will not contribute to an increase in output because of inefficient utilization. If the elasticity of output with respect to labor is known, it is possible to ascertain the output loss

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[13] Abram Bergson, "Market Socialism Revisited," in Comparative Economic Systems: A Reader, ed. by Marshall I. Goldman (New York: Random House, 1971), pp. 47-60.

due to structural disequilibrium. For example, in Table 4, Chapter IV, the elasticity of output with respect to labor is found to be 30.5 percent in 1964. From Appendix B, Table 2, it is found that man-hours increased during 1964-65 by 4.27 per cent, of which 24 percent (m = .24 based on the regression coefficients on page 72) will not contribute to output increases during the period. Multiplying the elasticity of output with respect to labor by the amount of the increase in labor lost (30.5 times 1.02) yields 3.11 per cent, which is a measure of the output loss associated with the existence of structural disequilibrium. Output, which grew by 8.1 percent during 1964-65, could have grown at a rate of 11.21 percent if the factors of production had been paid in proportion to their relative scarcities and if enterprise directors had reallocated input usage in response to these relative prices. An output loss of 3.11 percent is consistent with an estimate made by Judith Thornton of 4.15 per cent during the same year.[14]

Table 18, which repeats the above calculations for the years 1950-72, presents some idea of the increasing drag on output growth due to structural disequilibrium. For example, in 1971-72 the labor supply increased by 2.6 percent while the output loss during the same period was 2.13 percent. However, in 1951-52, when the increase in labor supply was nearly three times as large as in 1971-72,

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[14] Thornton, "Differential Capital Charges," p. 551.

TABLE 18

THE EFFICIENCY GAIN IN SOVIET INDUSTRY IN THE ABSENSE OF STRUCTURAL DISEQUILIBRIUM

Year	% increase in man-hours of labor	Man-hours not contri-buting to output, (%)	Output Loss (%)	Output Growth: Actual (%)	Output Growth: Potential (%)
1950-51	6.96	1.67	1.27	15.2	16.47
1951-52	3.64	0.87	0.90	11.4	12.30
1952-53	4.35	1.04	1.31	11.3	12.61
1953-54	4.84	1.16	1.66	12.9	14.56
1954-55	1.86	0.45	0.73	12.9	13.63
1955-56	-1.32	-1.00*	0.60	9.9	10.50
1956-57	0.29	0.07	0.15	10.9	11.05
1957-58	2.63	0.63	1.44	11.3	12.74
1958-59	1.53	0.37	0.90	11.4	12.30
1959-60	-0.66	-0.50*	0.41	10.4	10.81
1960-61	-0.46	-0.34*	0.33	9.6	9.99
1961-62	3.29	0.79	2.27	9.8	12.07
1962-63	3.63	0.85	2.51	9.1	11.61
1963-64	4.20	1.01	3.04	8.1	11.14
1964-65	4.27	1.02	3.11	8.2	11.31
1965-66	2.60	0.62	1.92	8.9	10.82
1966-67	3.28	0.79	2.49	9.6	12.09
1967-68	3.32	0.80	2.57	8.9	11.47
1968-69	2.41	0.58	1.89	7.7	9.59
1969-70	1.39	0.33	1.07	9.1	10.17

TABLE 18--Continued

Year	% increase in man-hours of labor	Man-hours not contributing to output, (%)	Output Loss (%)	Output Growth: Actual (%)	Output Growth: Potential (%)
1970-71	1.38	0.33	1.11	8.6	9.71
1971-72	2.60	0.62	2.13	7.8	9.93

*Indicates decrease in absence of structural disequilibrium.

Source: See text.

the output loss was only 1.27 percent, or nearly half that recorded in 1971-72. While it is likely that "capital accumulation has outstripped labor growth by a wide enough margin that the drag due to diminishing returns is significantly cutting into output growth" as Weitzman contends,[15] Table 18 demonstrates that this drag could be greatly reduced.

Summary

This chapter has examined output maximizing models of the Soviet firm in order to assess their relevance to the existence of structural disequilibrium verified empirically in Chapters III and IV. Output maximizing models of centrally planned enterprises demonstrate that under a selected constraint system, the director of an output maximizing enterprise may be required to react to relative

[15]Weitzman, "Postwar Soviet Economic Growth," p. 685.

prices in a manner similar to the manager of a profit maximizing firm. With respect to input demand functions, both profit and output maximizing firms would exhibit identical behavior.

Output maximizing models were not found to be inconsistent with the empirical determination of structural disequilibrium in Soviet industry, however, for two reasons. First, while such models determine the uniqueness of a competitive solution under the proper constraint system, they do not belie the existence of a noncompetitive solution under a different set of constraints. It was pointed out that the operation of both the Soviet bonus system and the multiple constraint system mitigate against the achievement of a competitive equilibrium. Second, such models rely on prices which reflect relative factor scarcities. It was shown that the determination of prices in the Soviet Union has proceeded apart from considerations of relative factor scarcities. Thus output maximizing models offer a theoretical remedy for the removal of structural disequilibrium but do not deny its existence, either theoretically or empirically.

Having earlier established the theoretical (Chapter II) and empirical (Chapters III and IV) existence of structural disequilibrium in postwar Soviet industry, this chapter provided an empirical determination of the cost (in terms of the potential growth of output) of disequilibrium. It was determined in Chapter IV that 24 per cent of the

annual growth in the labor force did not contribute to output growth because of misallocation. This knowledge, together with the estimates of the elasticity of output with respect to labor, made possible the determination of the potential growth of output in the absence of structural disequilibrium. It was found that yearly losses in output ranged from less than one per cent to over three per cent. It was also demonstrated that the drag on output growth due to the misallocation of labor has become relatively greater in the decade of the 1960's, reflecting both the absence of continuing extensive growth opportunities available to the Soviets and the increasing relative shortage of labor.

CHAPTER VI

SOVIET INDUSTRY UNDER STRUCTURAL DISEQUILIBRIUM: SUMMARY AND CONCLUSIONS

This study has dealt with the efficiency performance of the industrial sector of the Soviet economy during the postwar period (1950-1972). The allocative efficiency of one factor of production, labor, has been of particular interest throughout this study. The objectives of this study have been to examine the nature, extent and effect of structural disequilibrium, i.e., Soviet factor pricing policies which (1) allow a given factor to receive a different return in different uses and (2) make little attempt to insure that relative factor prices reflect relative factor scarcities. To achieve this objective it was necessary to do three things. First, set forth a theoretical framework within which disequilibrium relationships could be identified. Second, determine empirically the extent of structural disequilibrium. Third, show the effect any structural disequilibrium may have had on efficiency in Soviet industry, which required a measure of the output loss associated with such disequilibrium.

The postwar period is a fertile era for examining industrial efficiency for several reasons. First, the absence of rapid structural change lessens the effect of

index number relativity. Second, the increased availability of Soviet data on industrial output, capital stock, man-hours and wage rates has virtually eliminated the data lacunae so common to studies of the prewar period. Third, the decline in the rate of growth of industrial output since the early 1960's has prompted both Soviet and Western researchers to examine possible sources of inefficiency in the Soviet economy. Finally, the era of labor surpluses in the Soviet economy ended in the late 1950's and a new era of labor shortage began. Labor shortages, coupled with lagging productivity performances in the industrial labor force, focused attention squarely on the causes of this poor performance and means, other than rapidly increasing the size of the labor force (now no longer possible), to alleviate it.

The vehicle by which industrial efficiency was analyzed was the aggregate production function. An aggregate approach was employed, despite the inherent theoretical and empirical difficulties, because of the necessity of putting together an account of overall industrial growth. An analysis of Soviet industry on a sectoral basis was precluded as Soviet data releases continued to be highly aggregative in nature. Too, many of the problems of aggregation are relieved because the tautness of the Soviet system necessarily yields full employment capital-labor ratios. This is not generally the case in developed Western or underdeveloped countries.

Because an aggregate production function may take a variety of functional forms, it was necessary to employ a form which conformed to the empirical characteristics of Soviet industry. Specifically, the disparities in rates of growth of capital and labor inputs required a functional form which would admit a variable elasticity of substitution of capital for labor and variable elasticities of output with respect to capital and labor. Because of these requirements, both the Cobb-Douglas and constant elasticity of substitution production function specifications were rejected as inappropriate in the Soviet institutional setting.

In addition to the above requirements, it was necessary to specify the functional form in such a way as to permit the identification and measurement of structural disequilibrium. The constant-marginal-shares production function was found to meet all of these requirements. It admits a variable elasticity of substitution and variable elasticities of output with respect to labor and capital. It also allows for the explicit identification of structural disequilibrium in either the labor or capital factor market. The absence of meaningful rates of return on the Soviet capital stock made it necessary to concentrate on the labor market. However, in a two factor production function, disequilibrium in one factor market implies disequilibrium in the opposite direction in the other factor market. Therefore, any conclusion regarding the extent or effects of

disequilibrium are unaffected by the decision to explicitly identify disequilibrium in the labor market.

Having established an appropriate theoretical framework, the first hypothesis tested was "wages are not proportional to marginal productivities." Utilizing data on all nonagricultural, nonresidential activity, a positive discrepancy between wage rates and the marginal productivity of labor was found to exist, leading to an acceptance of this hypothesis. To insure that this result was not due to aggregation or a prewar price base, this hypothesis was tested using industrial data only valued in postwar prices. The results were similar; wages again exceeded marginal productivities. It was also noted that the obverse--the marginal productivity of capital exceeded rental rates--must necessarily also exist. From these results it was concluded that an appropriate theoretical framework allowed empirical verification of the existence of structural disequilibrium in postwar Soviet industry and that the nature of this disequilibrium was such that wages exceeded marginal productivities of labor and rental rates were exceeded by the marginal productivity of capital.

With the existence and nature of structural disequilibrium determined, it was necessary to determine the extent of this disequilibrium. To this end, the second hypothesis, that "utilization of the factors of production is sub-optimal, leading to a shortfall from the production

frontier," was tested. Again data at two levels of aggregation were used. Regardless of the level of aggregation, the second hypothesis was not rejected. Evidence of a statistically significant shortfall from the production frontier was found to exist. The statistical procedure used in obtaining this result consisted of a comparison of the error sums of squares of two production function specifications--the Cobb-Douglas function and the constant-marginal-shares function. It was necessary to test the hypothesis that the Cobb-Douglas specification, a more restrictive form because of its unitary elasticity of substitution and constant elasticities of output, was the "true" functional form. A modified F-test was performed and this hypothesis was rejected at the .90 level of significance.

Two important conclusions were reached as a result of the above tests. First, the evidence of production function shortfalls carried with it the implication that the decline in Soviet growth observable in the 1960's was not entirely the result of the maturing of the Soviet economy, the decline in the rates of growth of capital and labor, or declines in total factor productivity as previous research had indicated. Second, the rejection of the Cobb-Douglas function as the "true" functional form confirmed the *a priori* observation that because of the disparate growth rates of capital and labor in postwar Soviet industry, a more general production function specification

was required. This conclusion was confirmed by the estimated elasticity of substitution which was significantly less than one and the movement of output elasticities over the postwar period.

Having determined the nature and extent of structural disequilibrium in postwar Soviet industry, it was necessary to assess the effect this phenomenon had on the growth of output. Utilizing information obtained on the extent of structural disequilibrium and on the elasticities of output with respect to labor, it was found that nearly one quarter of the yearly increases in man-hours since 1950 were inefficiently employed and were unable to contribute to output increases. By translating these man-hour losses into potential output growth, it was found that the growth of output could have been an average of 1.53 per cent per year higher than that actually obtained over the entire postwar period. The losses on a yearly basis, however, proved more revealing. Because the elasticity of output with respect to labor had been rising steadily throughout the postwar period, the output drag associated with man-hour losses also steadily increased, being nearly twice as great in 1970-71 as in 1950-51. It was concluded that the existence of structural disequilibrium has hindered Soviet industrial growth and that as the shortage of industrial manpower relative to the capital stock became more acute in the 1960's, this hindrance to growth became more pronounced.

The above discussion leads to three general conclusions. First, while a pricing policy aimed at eliminating structural disequilibrium would have resulted in higher industrial growth rates in industry, it would not have prevented the declines in growth recorded in the 1960's. The tightening manpower situation and the Soviet decision to reduce investment growth would have required large increases in total factor productivity to offset the growth-retarding effects of declines in input growth. Second, because the effects of structural disequilibrium have become more pronounced in the 1960's, the Soviets must pay increasing attention to this problem in the 1970's if growth rates are not to decrease further. Finally, in order to implement such a pricing policy, the Soviets must free prices from the strictures of central determination and restructure the managerial bonus system in order to compel managers to respond to relative input prices. Given the alternatives of abandoning consumerism, continuing to draw off resources from agriculture where they are badly needed, or experiencing further declines in the growth of industrial output, the Soviet leadership may find such a policy highly advantageous.

APPENDIX A

The indexes in Table 19 are derived primarily from Western sources. Weitzman's methodology is employed,[1] with certain modifications, to the data from these sources. The purpose of this Appendix is to describe in detail the construction of the labor, capital, output and wage indexes.

Capital

The capital services index is drawn entirely from the data in Moorsteen and Powell[2] and two supplements to this work by these authors and Abraham Becker.[3] Table 4-A presents the components from which the capital services

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[1]Martin L. Weitzman, "Soviet Postwar Economic Growth and Capital-Labor Substitution," Cowles Foundation Discussion Paper No. 256, October 30, 1968.

[2]Richard Moorsteen and Raymond P. Powell, The Soviet Capital Stock, 1928-1962 (Homewood: Richard D. Irwin, Inc., 1966). This work is denoted by "MP" in the tabular section.

[3]Abraham S. Becker, Richard Moorsteen and Raymond P. Powell, "Two Supplements to Richard Moorsteen and Raymond P. Powell The Soviet Capital Stock, 1928-1962," The Economic Growth Center, Yale University, 1968. The first supplement, entitled "The Soviet Capital Stock: Revisions and Extension, 1961-1967," is by all three authors and will be referred to in the tabular material as "BMP." The second supplement, entitled "The Soviet Capital Stock and Related Series for the War Years," is by Powell and will be designated in the tabular section as "P."

index is drawn. Because the derivation is somewhat "roundabout" each component of this table will be described separately.

Capital: Construction

Derivation of construction capital proceeds from gross nonagricultural, nonresidential investment in construction (Table 1, Column 3) which is obtained by subtracting from gross nonagricultural investment in construction (Table 1, Column 1) all investment in housing construction (Table 1, Column 2). Gross nonagricultural, nonresidential investment at this point includes both "productive" and "nonproductive" investment--"nonproductive" investment defined basically as the service sector and including cultural, educational, scientific and health establishments. Table 2, derived from Soviet sources, indicates the per cent of total construction investments made in the "nonproductive" sectors, including agriculture. Therefore, the percentages in Table 2, Column 3, are applied to total gross investments in construction (Table 3, Column 1) and the resulting ruble figures (Table 3, Column 3) are subtracted from gross nonagricultural, nonresidential construction investments found in Table 1, Column 3. The result (Table 3, Column 4) is a gross nonresidential, nonagricultural, productive construction investment series hereafter referred to as industrial construction investment.

To arrive at an industrial construction capital stock, the investment series is added to the January 1, 1928 (Table 4, Column 1), yielding the unadjusted gross industrial construction capital stock (Table 6, Column 3). To account for wartime losses, an adjusted stock is obtained by reducing the extant 1940 stock by 25 per cent as suggested by Moorsteen-Powell.[4] Net industrial construction is not necessary for this study, but depreciation charges are one component of the capital services index. The annual depreciation charges are shown in Table 10, Column 4, and are derived by applying a 2 per cent average annual depreciation rate to the adjusted gross industrial construction capital stock.[5]

Capital: Equipment

The equipment component of industrial capital stock is obtained by subtracting from gross investment in equipment (Table 5, Column 1) gross investment in agricultural equipment (Table 5, Column 2), leaving gross investment in industrial equipment. There are no data on the per cent of equipment investment made in the "nonproductive" sector; therefore, no adjustments similar to those made for construction are attempted here. Such "nonproductive" equipment investments are likely to be a much smaller percentage

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[4]Moorsteen and Powell, Capital Stock, p. 75.

[5]Ibid., p. 67.

of total equipment investments than was the case for construction and only a slight upward bias in total capital services should result.

From gross investment in industrial equipment, the unadjusted equipment capital stock is obtained by adding this investment series to the January 1, 1928 stock (Table 4, Column 2), and the adjustment for wartime losses is the same as that made in construction. Depreciation rates on equipment are obtained by applying the composite depreciation rates of Table 5 to the gross investment series of Table 5, Column 3. These depreciation charges are shown in Table 9.

Capital: Installation

Industrial installation capital stock is derived by adding to the January 1, 1928 installation stock the installation investment series in MP, p. 387 and BMP, p. 32. No adjustment for agricultural installation is made as most agricultural equipment needs no installation.[6] The depreciation charges in Table 10, Column 2, were obtained by applying a 2½ per cent annual depreciation rate to the stock series described above.[7]

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[6] Ibid., p. 427.

[7] Ibid., p. 67.

Capital Services

From the preceeding operations an industrial capital stock may be obtained. However, as Moorsteen-Powell have argued, what is necessary for the measurement of factor productivity is not the capital stock. Rather, what is needed "is a measure of 'capital services,' i.e., a measure in which assets are weighted in proportion to the value of the marginal products imputable to them during the period of the weight year, for one another and for other kinds of inputs. It is this which determines their substitutability in use in the weight year, for one another and for other kinds of inputs."[8] Therefore, to obtain an index of gross capital services, defined as interest plus depreciation charges, the following procedure is employed: to the depreciation charges of Tables 9 and 10 are added imputed interest charges. The interest rate is assumed to be equal among the sectors in order to compute the interest charges on the average gross capital stock per year.

To obtain the average capital stock during any one year the following formula is employed:[9]

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[8] Ibid., p. 10.

[9] Martin L Weitzman, "Soviet Postwar Economic Growth and Capital-Labor Substitution," American Economic Review, LX (September, 1970), p. 689.

$$(1) \qquad K_t = J_{t-1} \int_0^t e^{\gamma t}\, dt$$

where K_t = average capital stock during year t

J_t = capital stock at the end of year t

$e^{\gamma t} = J_t / J_{t-1}$.

By interpolation, (1) yields the following computation formula:

$$(2) \qquad K_t = (J_t - J_{t-1})/(\ln J_t - \ln J_{t-1})$$

Equation (2) is applied to the sum of the components of Table 6, which depicts end-of-year stocks, with an assumed interest rate of 10 per cent.[10] These calculations, plus depreciation charges, yield the capital index of Table 19, Column 2, normalized to 1937 = 100.

Labor

The labor force data presented in Table 12 are drawn from two recent RAND studies by Kaplan[11] and a Cowles Foundation Discussion Paper by Weitzman.[12] The producers co-op category was abandoned in 1959; the independent artisans category in 1963. Industrial work in agriculture is based on the information in Table 10, which shows the per cent of the total agricultural work force performing industrial work. The per cent of the agricultural labor force

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[10] The interest rate is entirely arbitrary. Weitzman uses 10 per cent but almost all studies of this sort agree that any results are virtually unaffected by the rate chosen. The imputed rate is usually between 8 and 20 per cent.

[11] Norman Kaplan, The Record of Soviet Economic Growth, 1928-1965, The RAND Corporation, RM-6169, 1969 and Earnings Distribution in the USSR, The RAND Corporation, RM-6170, 1969.

[12] Weitzman, Cowles Discussion Paper.

in industry has remained fairly constant at 10 per cent over time; therefore, where no data are available it is assumed that the per cent was 10 per cent.[13] The one exception is the period 1928-1933. For this period Bergson estimates the percentage to be between 10 and 15 per cent and 12.5 per cent was arbitrarily chosen. In Table 13 where the percentages were not shown in Moorsteen-Powell or Bergson they are enclosed in parentheses.

Table 14 shows the average hours worked per day and the actual days worked per year for large scale industry. These are the only data on work time available except for scattered years in certain industries.[14] This study follows Weitzman in assuming that the average hours worked per year in industry reflects the situation in all other sectors.[15] Table 14, Column 4, gives the man-hours worked per year and it is this column, with 1937 = 100, which is indexed in Table 19, Column 3.

For the purpose of obtaining an average annual wage figure the data in Table 9 are adjusted in Table 16. This adjustment is necessary because producers co-ops appear as a separate category in the labor force data while wage data by sector include members of producers co-ops assigned

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[13]Moorsteen and Powell, Capital Stock, p. 645.

[14]Actually such data are extant for only two years, 1963 and 1964, and for only seven branches of industry.

[15]Weitzman, American Economic Review, p. 687.

to that sector. Producers co-op members must be distributed among the other sectors in order to get a properly weighted average wage rate by sector.

To accomplish this, the following footnote in the annual national economy handbook is taken as a point of departure:

> Included in the number of workers and employees in 1960 are 1.4 million former members of producers cooperatives, transferred in 1960 among the state enterprise system, including 1.2 million persons to industry, 0.1 million persons to housing and communial services, and 0.1 million persons to construction, transport and other branches.[16]

This breakdown is as follows: 85.7 per cent to industry, 7.1 per cent to housing and communial services, and 7.1 per cent to construction, transport and other branches. The percentage employment breakdown in 1960 among these latter branches is: construction, 30.42 per cent; transportation, 37.14 per cent; communications, 4.37 per cent and trade, 28.07 per cent. The 7.1 per cent is allocated to these branches on the basis of their employment weights, yielding the following percentage distribution for producers cooperatives among all sectors:

Industry.	85.70
Construction . . .	2.16
Transportation . .	2.64
Communications . .	0.31
Trade	1.99

It is assumed that this percentage breakdown is indicative of the breakdown for all years in determining

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[16] Tsentral'noe statisticheskoe uprovlenie, Narodnoe khoziaistvo SSSR v 1960 godu, Moscow, 1961, p. 637.

the figures in Table 15. Table 16 is derived by adding to the sectoral breakdown of employment in Table 12 the distribution of producers co-op members in Table 15. Columns 6 and 7 of Table 16 are explained below in the discussion of wages.

Wages

Wage data for the Soviet Union are scarce indeed and a number of assumptions must be made in determining an average annual earnings figure for the sectors included in this study. Table 14 presents average monthly earnings by sector for 1928-1966. These data are drawn primarily from Soviet sources for the years 1928-1935, 1937, 1940, 1945, 1950, 1955, 1958 and 1960-1966.[17] The 1951-1954 industrial wage rates are taken from Bergson.[18] Bergson's study was completed before the recent wage data[19] were made available and his estimates can be checked against the available data for the years 1940, 1950 and 1955. In 1940 Bergson's estimates correspond almost exactly to the published sources, in 1950 his estimates are below those given, in 1955 his estimates are above those recently released by 2.42 per cent. Therefore Bergson's estimates are

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[17] These are the only years the Soviets have released earnings data.

[18] Abram Bergson, The Real National Income of Soviet Russia Since 1928 (Cambridge: Harvard University Press, 1961), p. 422.

[19] It was in 1965, with the publication of the 1964 national handbook, that the first postwar data on money wages were published. Fortunately this practice has been continued in subsequent handbooks.

reduced by 2.42 per cent for 1953 and 1954 and use as given the estimates for 1951 and 1952.

For the years in which no wage data are extant earnings are determined by calculating average annual growth rates. These interpolated estimates are shown in parentheses and include the years 1936, 1938-1939, 1946-1949, 1951-1954, 1956 and 1957 for all sectors except industry as explained above. The 1959 wage figures are taken from a recent Joint Economic Committee report.[20] Calculating wages by interpolation involves less error than might be expected since for the periods of greatest relative wage changes among sectors, 1928-1937 and post-1956, direct Soviet sources can be relied upon. In this respect, Bergson's wage estimates for 1951-1954 which were determined by interpolation are, in the light of newly available data, very close to the mark.

For the entire period it is assumed that the agricultural work force engaged in industrial activities receives the same annual wage as agricultural workers on the state farms. For the 1928-1935 period, wage data are presented separately for forestry. Treml is followed in using the sovhkoz wage figure for forestry.[21] As Table 17 shows,

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[20]Murray Feshbach and Stephen Rapaway, "Labor and Wages," Economic Performance and the Military Burden in the Soviet Union, Joint Economic Committee, 1970, p. 82.

[21]Vladimir G. Treml, Dimitri M. Gallik, Barry L. Kostinsky and Kurt W. Kruger, The Structure of the Soviet Economy: Analysis and Reconstruction of the 1966 Input-Output Table (New York: Praeger Publishers, 1972), p. 342.

by 1935 the sovhkoz and forestry rates are nearly identical.

Independent artisans and other and residual categories are included together and it is assumed they receive an annual average wage equal to the annual average wage for the entire economy, again following Treml.[22] Soviet data do give wage data for a residual category which is known to include those workers in the combined artisans-residual category.[23] However, the stated average monthly earnings figure for this category is always well above the sectoral earnings figures and the global figures--sometimes by as much as 60 per cent. The residual category is known to include what the Soviets call "project-making" as well as literature and art in addition to the repair workers this category is hoping to capture. In an effort to net out these highly paid artists, writers and researchers, the annual average wage earnings for the entire economy are assumed to be the same as the annual average earnings of repair workers.

To arrive at average annual earnings, the following formula is employed:

$$(3) \qquad W = \sum_{i=1}^{n} W_i(E_i/E_t) \times 12$$

where W = average annual earnings, all sectors

E_i = employment in the ith sector

E_t = total employment

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[22] Ibid., p. 342.

[23] Kaplan, Earnings, p. 132.

The multiple of twelve is used with some confidence as Kaplan has cross-checked average monthly earnings against average annual earnings for all sectors and for the entire economy and concludes that[24]

> although there are some ambiguities here, the comparisons are in general in support of the hypothesis that average monthly earnings are one-twelfth of average annual earnings.

Table 18 presents average annual earnings by sector and, in the final column, the grand mean for all sectors. It is this last column which is indexed in Table 19, Column 4, normalized to 1937 = 100.

Output

Components of the index of industrial production appear in Table 11 and are taken directly from Moorsteen-Powell. These data are "indexes of the physical volume of output by sectors of origin."[25] To obtain the industrial production index shown in Table 19, Column 1, these indexes are aggregated using the following 1937 value-added weights:[26]

Civilian Industry	58.58
Munitions Industry	4.85
Construction	10.18
Transportation and Communications	16.30
Trade and Restaurants	10.09

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[24] Ibid., p. 129.

[25] Moorsteen and Powell, Capital Stock, p. 619.

[26] Ibid., p. 622.

The Moorsteen-Powell data were chosen for their comprehensiveness as they encompass the years 1928-1966. Generally the differences between Western indexes of Soviet output devolve into questions of the proper sectoral weighting used in whatever base year is chosen.[27] Ultimately a variety of weights and base years will be used, but the derivation of alternative indexes is virtually identical to that shown here.

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[27]Kaplan, Soviet Growth, p. 6.

TABLE 1

DERIVATION OF INDUSTRIAL CONSTRUCTION CAPITAL STOCK (BILLIONS OF 1937 RUBLES)

Year	Total non-agricultural construction	Housing Construction	Total non-agricultural non-residential construction
1928	6.09	2.5	3.59
1929	7.78	2.5	5.28
1930	10.98	2.5	8.48
1931	11.99	2.5	9.49
1932	12.41	2.5	9.91
1933	10.17	2.3	7.87
1934	12.50	2.3	10.20
1935	15.66	2.3	13.36
1936	21.43	2.3	19.13
1937	17.55	2.3	15.25
1938	17.08	3.4	13.68
1939	17.69	3.4	14.29
1940	17.40	3.4	14.00
1941, 1st half	8.71	3.4	5.31
1941, 2nd half	2.91	1.7	1.21
1942	5.87	3.3	2.57
1943	5.92	3.3	2.62
1944	7.50	3.3	4.20
1945	7.25	1.7	5.55
1946	10.39	2.4	7.99
1947	12.46	4.9	7.56
1948	16.75	5.6	11.15
1949	21.89	5.8	16.09
1950	24.77	6.4	18.37
1951	28.10	7.1	21.00
1952	32.04	6.9	25.14
1953	35.27	7.8	27.47
1954	38.47	8.1	30.37
1955	40.76	8.3	32.46
1956	43.71	10.0	33.71
1957	47.23	13.1	34.13
1958	53.25	16.7	36.55
1959	60.13	18.9	41.23
1960	65.35	19.1	46.25
1961	67.70	19.0	48.70
1962	70.20	19.2	51.00
1963	72.00	19.0	53.00
1964	73.70	18.0	55.70
1965	78.20	19.1	59.10
1966	82.60	19.5	63.10

Sources: Column 1: 1928-1960, MP, p. 440; 1961-1966, BMP, p. 36. Column 2: 1928-1960, MP, p. 88; 1961-1966, BMP, p. 32. Column 3: Column 1 minus Column 2.

TABLE 2

DERIVATION OF NON-PRODUCTIVE INDUSTRIAL CONSTRUCTION CAPITAL STOCK (MILLIONS OF 1955 RUBLES)

Year	Building and construction investments	Non-productive building and construction investments*	Non-productive investments (%)
1928-1933	6,200	191	3.08
1934-1937	13,300	781	5.87
1938-1941	13,700	720	5.26
1942-1945	13,900	327	2.35
1946-1951	28,200	1,344	4.77
1952-1956	51,700	2,865	5.54
1957-1960	49,900	3,290	6.59
1961	24,300	2,354	9.69
1962	24,700	2,541	10.29
1963	25,200	2,554	10.13
1964	26,700	2,806	10.51
1965	29,000	8,589	29.62
1966	31,000	3,336	10.76

*Includes scientific, cultural, educational and health establishments.

Source: Column 1: Strana Sovetov za 50 Let, pp. 202-03. Column 2: Strana Sovetov za 50 Let, p. 198. Col. 3: Column 2 ÷ Column 1.

TABLE 3

DERIVATION OF NON-PRODUCTIVE INDUSTRIAL CONSTRUCTION CAPITAL STOCK-II (BILLIONS OF 1937 RUBLES)

Year	Fixed capital investments: construction	Non-productive investments (%)	Non-productive fixed capital investments: construction	Productive fixed capital investments: construction
1928	7.20	3.08	0.24	3.35
1929	9.02	3.08	0.28	5.00
1930	12.30	3.08	0.38	8.10
1931	13.56	3.08	0.42	9.07
1932	13.62	3.08	0.42	9.64
1933	11.90	3.08	0.37	7.50
1934	14.35	5.87	0.84	9.36
1935	17.66	5.87	1.04	12.32
1936	23.92	5.87	1.40	17.73
1937	20.27	5.87	1.19	14.06
1938	19.48	5.26	1.02	12.66
1939	20.17	5.26	1.06	13.23
1940	19.84	5.26	1.04	12.96
1941 1st ½	9.93	5.26	0.52	4.79
1941 2nd ½	3.32	2.35	0.08	1.13
1942	6.69	2.35	0.16	2.41
1943	6.75	2.35	0.16	2.46
1944	8.55	2.35	0.20	4.00
1945	8.27	2.35	0.19	5.36
1946	12.10	4.77	0.58	7.41
1947	14.51	4.77	0.69	6.87
1948	19.50	4.77	0.93	10.22
1949	25.48	4.77	1.22	14.87
1950	28.84	4.77	1.38	16.99
1951	32.90	4.77	1.57	19.43
1952	36.87	5.54	2.04	23.10
1953	40.22	5.54	2.23	25.24
1954	44.68	5.54	2.48	27.89
1955	48.87	5.54	2.71	29.75
1956	51.97	5.54	2.88	30.83
1957	56.49	6.59	3.72	30.41
1958	63.24	6.59	4.17	32.38
1959	70.74	6.59	4.66	36.57
1960	75.99	6.59	5.01	41.24
1961	79.50	9.69	7.70	41.00
1962	83.50	10.29	8.59	42.41
1963	86.10	10.13	8.72	44.28
1964	89.70	10.51	9.43	46.27
1965	94.60	29.62	28.02	31.08
1966	100.00	10.76	10.76	52.34

Source: Column 1, 1928-1960, MP, p. 387; 1961-1966, BMP, p. 32. Column 2: Table 1-B. Column 3: Column 1 X's Column 2. Column 4: Column 3, Table 1-A minus Column 3, above.

TABLE 4

INDUSTRIAL CAPITAL STOCK, JANUARY 1, 1928
(MILLIONS OF 1937 RUBLES)

Sector	Structures	Equipment	Installation
Industry	9,857	5,254	2,424
Electric Power	1,192	342	226
Railroads	18,573	6,591	.....
Water Transport	922	737	.....
Motor Transport	1,841	2	.....
Communications	487	86	74
Trade	1,325	232	.....
Total	33,610	13,244	2,724

Source: MP, p. 413.

TABLE 5

DERIVATION OF INDUSTRIAL EQUIPMENT INVESTMENT
(BILLIONS OF 1937 RUBLES)

Year	Investment in fixed capital: construction	Investment in fixed capital: agriculture	Investment in fixed capital: industry construction
1928	2.02	0.49	1.53
1929	2.73	0.61	2.12
1930	4.73	1.06	3.67
1931	5.60	1.32	4.28
1932	6.36	1.16	5.20
1933	5.85	1.62	4.23
1934	5.90	1.63	4.27
1935	7.60	2.08	5.52
1936	10.80	2.73	8.07
1937	11.00	2.46	8.54
1938	12.20	2.10	10.10
1939	11.50	1.87	9.63
1940	11.00	1.40	9.60
1941 1st ½	5.55	0.70	4.85
1941 2nd ½	1.85	0.35	1.50
1942	3.70	0.00	3.70
1943	3.36	0.00	3.36
1944	8.60	0.37	8.23
1945	12.10	0.73	11.37
1946	13.50	1.21	12.29
1947	15.20	1.75	13.45
1948	16.90	2.60	14.30
1949	18.50	4.51	13.99
1950	24.20	6.14	18.06
1951	25.50	6.20	19.30
1952	25.10	5.87	19.23
1953	28.20	6.00	22.20
1954	33.80	6.62	27.18
1955	41.40	7.83	33.57
1956	52.10	8.84	43.26
1957	57.31	9.42	47.89
1958	66.11	10.88	55.23
1959	71.48	9.67	61.81
1960	76.27	8.53	67.74
1961	83.90	9.40	74.50
1962	93.80	10.60	83.20
1963	103.00	12.30	90.70
1964	115.90	14.90	101.00
1965	123.10	16.90	106.20
1966	131.20	18.10	113.10

Source: Column 1: 1928-1960, MP, p. 387; 1961-1966, BMP, p. 32. Column 2: 1928-1960, MP, p. 438; 1961-1966, BMP, p. 35. Column 3: Column 1 minus Column 2.

TABLE 6

GROSS INDUSTRIAL CAPITAL STOCK BY ECONOMIC SECTOR:
UNADJUSTED AND ADJUSTED FOR WAR LOSS
(BILLIONS OF 1937 RUBLES)

Year	Installation		Construction		Equipment	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
1928	3.06	3.06	36.96	36.96	14.77	14.77
1929	3.50	3.50	41.96	41.96	16.89	16.89
1930	4.15	4.15	50.06	50.06	20.56	20.56
1931	4.90	4.90	59.13	59.13	24.84	24.84
1932	5.69	5.69	68.77	68.77	30.04	30.04
1933	6.40	6.40	76.27	76.27	34.27	34.27
1934	7.19	7.19	85.63	85.63	38.54	38.54
1935	8.19	8.19	97.95	97.95	44.06	44.06
1936	9.55	9.55	115.68	115.68	52.13	52.13
1937	10.79	10.79	129.74	129.74	60.67	60.67
1938	12.08	12.08	142.40	142.40	70.77	70.77
1939	13.36	13.36	155.63	155.63	80.40	80.40
1940	14.61	10.51	168.59	126.44	90.00	67.50
1941 1st ½	15.26	11.16	173.38	131.23	94.85	72.35
1941 2nd ½	15.53	11.43	174.51	132.36	96.35	73.85
1942	15.98	11.88	176.92	134.77	100.05	77.55
1943	16.45	12.35	179.38	137.23	103.41	80.91
1944	17.22	13.12	183.38	141.23	111.64	89.14
1945	18.14	14.04	188.74	146.59	131.24	108.74
1946	19.26	15.16	196.15	154.00	143.53	121.03
1947	20.51	16.41	203.02	160.87	156.98	134.48
1948	22.00	17.90	213.24	171.09	171.28	148.78
1949	23.78	19.68	228.11	185.96	185.27	162.77
1950	25.99	21.89	245.10	202.95	203.33	180.83
1951	28.43	24.33	264.53	222.38	222.63	200.13
1952	31.02	26.92	287.63	245.48	241.86	219.36
1953	33.86	29.76	312.87	270.72	264.06	241.56
1954	37.14	33.04	340.76	298.61	291.24	268.74
1955	40.90	36.80	370.51	328.36	324.81	302.31
1956	45.33	41.23	401.34	359.19	368.07	345.57
1957	50.19	46.09	431.75	389.60	415.96	393.46
1958	55.73	51.63	464.13	421.98	471.19	448.69
1959	61.79	57.69	500.70	458.55	533.00	510.50
1960	68.28	64.18	541.94	499.79	600.74	578.24
1961	75.28	71.18	582.94	540.79	675.24	652.74
1962	82.98	78.88	625.35	583.20	758.44	735.95
1963	91.18	87.08	669.63	627.48	849.14	826.64
1964	100.28	96.18	715.90	673.75	950.14	927.64
1965	109.88	105.78	746.98	704.83	1056.34	1033.84
1966	120.08	115.98	799.32	757.17	1169.44	1146.94

Source: Column 1: 1928-1960, MP, p. 387; 1961-1966, BMP, p. 32; Table 2. Column 3: Table 1-C and Table 2. Column 5: Table 2 and Table 3. Columns 2, 4 and 6: see text.

TABLE 7

AVERAGE ANNUAL CAPITAL STOCK AND CAPITAL SERVICES
(BILLIONS OF 1937 RUBLES)

Year	Average Annual Capital Stock	Interest Charges*	Depreciation	Capital Services
1928	52.13	5.21	0.20	5.41
1929	58.49	5.85	0.47	6.32
1930	68.37	6.84	0.93	7.77
1931	81.61	8.16	1.45	9.61
1932	96.47	9.65	2.06	11.71
1933	110.60	11.06	2.55	13.61
1934	124.02	12.40	3.08	15.48
1935	140.57	14.06	3.76	17.82
1936	163.41	16.34	4.68	21.02
1937	189.06	18.91	5.54	24.45
1938	212.99	21.30	6.40	27.70
1939	237.13	23.71	7.19	30.90
1940	261.10	26.11	7.91	34.02
1945	256.21	25.62	9.14	34.76
1946	279.64	27.96	9.67	37.63
1947	300.84	30.08	10.30	40.38
1948	324.57	32.46	11.05	43.51
1949	352.88	35.29	12.11	47.40
1950	386.80	38.68	13.51	52.19
1951	425.88	42.59	15.15	57.74
1952	468.95	46.90	16.63	63.53
1953	516.47	51.65	18.26	69.91
1954	570.75	57.08	20.24	77.32
1955	633.32	63.32	22.66	85.98
1956	705.98	70.60	25.84	96.44
1957	786.87	78.69	29.31	108.00
1958	874.87	87.49	33.22	120.71
1959	980.36	98.04	37.60	135.64
1960	1076.01	107.60	42.56	150.16
1961	1202.44	120.24	47.82	168.06
1962	1330.25	133.03	53.52	186.55
1963	1468.41	146.84	59.49	206.33
1964	1618.08	161.81	65.82	227.63
1965	1769.96	177.00	71.97	248.97
1966	1926.66	192.67	78.66	271.33

*Assumed to be 10 per cent.

Source: Tables 4, 6, and 7.

TABLE 8

COMPOSITE DEPRECIATION RATES FOR ANNUAL INVESTMENT IN INDUSTRIAL EQUIPMENT

Years after Aquisition of Asset	Annual Depreciation Chargeable against Assets Remaining in Existence: Composite
0- 3	7.6
4- 5	7.5
6- 8	7.5
9-10	2.6
11	2.3
12	1.9
13-20	1.5
21-25	1.5
26-30	0.8
31-40	0.5
41-45	0.4
46-50	0.1
over 50	0.0

Source: MP, p. 66.

TABLE 9

DEPRECIATION CHARGES: INDUSTRIAL EQUIPMENT
(BILLIONS OF 1937 RUBLES)

Year Depreciation Charge is Taken	Year of Investment									
	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937
1928	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1929	0.12	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1930	0.12	0.16	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1931	0.11	0.16	0.28	0.33	0.00	0.00	0.00	0.00	0.00	0.00
1932	0.11	0.16	0.28	0.33	0.40	0.00	0.00	0.00	0.00	0.00
1933	0.11	0.16	0.28	0.33	0.40	0.32	0.00	0.00	0.00	0.00
1934	0.11	0.16	0.28	0.32	0.40	0.32	0.32	0.00	0.00	0.00
1935	0.11	0.16	0.28	0.32	0.39	0.32	0.32	0.42	0.00	0.00
1936	0.04	0.16	0.28	0.32	0.39	0.32	0.32	0.42	0.61	0.00
1937	0.04	0.06	0.28	0.32	0.39	0.32	0.32	0.42	0.61	0.65
1938	0.04	0.06	0.10	0.32	0.39	0.32	0.32	0.41	0.61	0.65
1939	0.03	0.05	0.10	0.11	0.39	0.32	0.32	0.41	0.61	0.65
1940	0.02	0.04	0.08	0.11	0.14	0.32	0.32	0.41	0.61	0.64
1941*	0.01	0.02	0.04	0.05	0.14	0.06	0.16	0.21	0.31	0.32
1941*	0.01	0.01	0.03	0.05	0.12	0.05	0.16	0.20	0.30	0.32
1942	0.02	0.03	0.06	0.08	0.12	0.11	0.11	0.41	0.61	0.64
1943	0.02	0.03	0.06	0.06	0.10	0.10	0.11	0.14	0.61	0.64
1944	0.02	0.03	0.06	0.06	0.08	0.08	0.10	0.14	0.21	0.64
1945	0.02	0.03	0.06	0.06	0.08	0.06	0.08	0.13	0.21	0.22
1946	0.02	0.03	0.06	0.06	0.08	0.06	0.06	0.10	0.19	0.22
1947	0.02	0.03	0.06	0.06	0.08	0.06	0.06	0.08	0.15	0.20
1948	0.02	0.03	0.06	0.06	0.08	0.06	0.06	0.08	0.12	0.16
1949	0.02	0.03	0.06	0.06	0.08	0.06	0.06	0.08	0.12	0.13
1950	0.02	0.03	0.06	0.06	0.08	0.06	0.06	0.08	0.12	0.13
1951	0.02	0.03	0.06	0.06	0.08	0.06	0.06	0.08	0.12	0.13
1952	0.02	0.03	0.06	0.06	0.08	0.06	0.06	0.08	0.12	0.13
1953	0.01	0.03	0.06	0.06	0.08	0.06	0.06	0.08	0.12	0.13
1954	0.01	0.02	0.06	0.06	0.08	0.06	0.06	0.04	0.12	0.13
1955	0.01	0.02	0.03	0.03	0.08	0.06	0.06	0.04	0.12	0.13
1956	0.01	0.02	0.03	0.03	0.08	0.06	0.06	0.04	0.12	0.13
1957	0.01	0.02	0.03	0.03	0.04	0.06	0.06	0.04	0.12	0.13
1958	0.01	0.02	0.03	0.03	0.04	0.03	0.06	0.04	0.12	0.13
1959	0.01	0.02	0.03	0.03	0.04	0.03	0.03	0.03	0.12	0.13
1960	0.01	0.01	0.02	0.02	0.04	0.03	0.03	0.03	0.12	0.13
1961	0.01	0.01	0.02	0.02	0.04	0.03	0.03	0.03	0.07	0.13
1962	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.07	0.07
1963	0.01	0.01	0.02	0.02	0.03	0.02	0.03	0.03	0.07	0.07
1964	0.01	0.01	0.02	0.02	0.03	0.02	0.02	0.03	0.07	0.07
1965	0.01	0.01	0.02	0.02	0.03	0.02	0.02	0.03	0.07	0.07
1966	0.01	0.01	0.02	0.02	0.03	0.02	0.02	0.03	0.04	0.07

TABLE 9--Continued

Year Depreciation Charge is Taken	Year of Investment									
	1938	1939	1940	1941	1941	1942	1943	1944	1945	1946
1928	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1929	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1930	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1931	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1932	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1933	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1934	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1935	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1936	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1937	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1938	0.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1939	0.77	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1940	0.77	0.73	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1941*	0.38	0.37	0.37	0.19	0.00	0.00	0.00	0.00	0.00	0.00
1941*	0.38	0.36	0.36	0.18	0.06	0.00	0.00	0.00	0.00	0.00
1942	0.76	0.72	0.73	0.37	0.11	0.28	0.00	0.00	0.00	0.00
1943	0.76	0.72	0.72	0.37	0.11	0.28	0.26	0.00	0.00	0.00
1944	0.76	0.72	0.72	0.36	0.11	0.28	0.26	0.63	0.00	0.00
1945	0.76	0.72	0.72	0.36	0.11	0.28	0.26	0.63	0.86	0.00
1946	0.26	0.72	0.72	0.36	0.11	0.28	0.25	0.63	0.86	0.93
1947	0.26	0.25	0.72	0.36	0.11	0.28	0.25	0.62	0.86	0.93
1948	0.23	0.25	0.25	0.36	0.11	0.28	0.25	0.62	0.85	0.93
1949	0.19	0.22	0.25	0.13	0.11	0.28	0.25	0.62	0.85	0.92
1950	0.15	0.18	0.22	0.13	0.04	0.10	0.25	0.62	0.85	0.92
1951	0.15	0.14	0.18	0.11	0.04	0.10	0.09	0.62	0.85	0.92
1952	0.15	0.14	0.14	0.09	0.03	0.09	0.09	0.21	0.85	0.92
1953	0.15	0.14	0.14	0.07	0.03	0.07	0.08	0.21	0.30	0.92
1954	0.15	0.14	0.14	0.07	0.02	0.06	0.06	0.19	0.30	0.32
1955	0.15	0.14	0.14	0.07	0.02	0.06	0.05	0.16	0.26	0.32
1956	0.15	0.14	0.14	0.07	0.02	0.06	0.05	0.12	0.22	0.28
1957	0.15	0.14	0.14	0.07	0.02	0.06	0.05	0.12	0.17	0.23
1958	0.15	0.14	0.14	0.07	0.02	0.06	0.05	0.12	0.17	0.18
1959	0.15	0.14	0.14	0.07	0.02	0.06	0.05	0.12	0.17	0.18
1960	0.15	0.14	0.14	0.07	0.02	0.06	0.05	0.12	0.17	0.18
1961	0.15	0.14	0.14	0.07	0.02	0.06	0.05	0.12	0.17	0.18
1962	0.15	0.14	0.14	0.07	0.02	0.06	0.05	0.12	0.17	0.18
1963	0.08	0.14	0.14	0.07	0.02	0.06	0.05	0.12	0.17	0.18
1964	0.08	0.08	0.14	0.07	0.02	0.06	0.05	0.12	0.17	0.18
1965	0.08	0.08	0.08	0.07	0.02	0.06	0.05	0.12	0.17	0.18
1966	0.08	0.08	0.08	0.04	0.02	0.06	0.05	0.12	0.17	0.18

TABLE 9--Continued

Year Depreciation Charge is Taken	Year of Investment										
	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
1928	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1929	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1930	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1931	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1932	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1933	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1934	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1935	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1936	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1937	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1938	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1939	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1940	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1941*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1941*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1942	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1943	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1944	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1945	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1946	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1947	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1948	1.02	1.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1949	1.02	1.09	1.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1950	1.01	1.09	1.06	1.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1951	1.01	1.07	1.06	1.37	1.47	0.00	0.00	0.00	0.00	0.00	0.00
1952	1.01	1.07	1.05	1.37	1.47	1.46	0.00	0.00	0.00	0.00	0.00
1953	1.01	1.07	1.05	1.35	1.47	1.46	1.69	0.00	0.00	0.00	0.00
1954	1.01	1.07	1.05	1.35	1.45	1.46	1.69	2.07	0.00	0.00	0.00
1955	0.35	1.07	1.05	1.35	1.45	1.44	1.69	2.07	2.55	0.00	0.00
1956	0.35	0.37	1.05	1.35	1.45	1.44	1.67	2.07	2.55	3.29	0.00
1957	0.31	0.37	0.36	1.35	1.45	1.44	1.67	2.04	2.55	3.29	3.64
1958	0.26	0.33	0.36	0.47	1.45	1.44	1.67	2.04	2.52	3.29	3.64
1959	0.20	0.27	0.32	0.47	0.50	1.44	1.67	2.04	2.52	3.24	3.64
1960	0.20	0.21	0.27	0.42	0.50	0.50	1.67	2.04	2.52	3.24	3.59
1961	0.20	0.21	0.21	0.34	0.44	0.50	0.58	2.04	2.52	3.24	3.59
1962	0.20	0.21	0.21	0.27	0.37	0.44	0.58	0.71	2.52	3.24	3.59
1963	0.20	0.21	0.21	0.27	0.29	0.37	0.51	0.71	0.87	3.24	3.59
1964	0.20	0.21	0.21	0.27	0.29	0.29	0.42	0.63	0.87	1.12	3.59
1965	0.20	0.21	0.21	0.27	0.29	0.29	0.33	0.52	0.77	1.12	1.25
1966	0.20	0.21	0.21	0.27	0.29	0.29	0.33	0.41	0.64	0.99	1.25

TABLE 9--Continued

Year Depreciation Charge is Taken	Year of Investment									Total
	1958	1959	1960	1961	1962	1963	1964	1965	1966	
1928	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12
1929	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28
1930	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.56
1931	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88
1932	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.28
1933	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.60
1934	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.92
1935	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.32
1936	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.86
1937	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.41
1938	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.99
1939	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.49
1940	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.92
1941*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.63
1941*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.59
1942	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.16
1943	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.09
1944	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.26
1945	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.65
1946	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00
1947	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.46
1948	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.97
1949	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.69
1950	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.69
1951	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.88
1952	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.84
1953	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.90
1954	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.24
1955	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.97
1956	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	17.42
1957	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.16
1958	4.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.28
1959	4.20	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	26.78
1960	4.20	4.70	5.15	0.00	0.00	0.00	0.00	0.00	0.00	30.75
1961	4.14	4.70	5.15	5.66	0.00	0.00	0.00	0.00	0.00	35.01
1962	4.14	4.64	5.15	5.66	6.32	0.00	0.00	0.00	0.00	39.67
1963	4.14	4.64	5.08	5.66	6.32	6.89	0.00	0.00	0.00	44.54
1964	4.14	4.64	5.08	5.59	6.32	6.89	7.68	0.00	0.00	49.71
1965	4.14	4.64	5.08	5.59	6.24	6.89	7.68	8.07	0.00	55.00
1966	1.44	4.64	5.08	5.59	6.24	6.80	7.68	8.07	8.60	60.38

*Annual depreciation charge divided equally between 1941, 1st half and 1941, 2nd half.

Source: Depreciation rates in Table 5 applied to the investment figures in Table 3.

TABLE 10

DEPRECIATION CHARGES: INDUSTRIAL CONSTRUCTION AND INSTALLATION (BILLIONS OF 1937 RUBLES)

Year	Installation		Construction	
	Annual Charge	Cumulative Total	Annual Charge	Cumulative Total
1928	0.01	0.01	0.07	00.07
1929	0.01	0.02	0.10	00.17
1930	0.02	0.04	0.16	00.33
1931	0.02	0.06	0.18	00.51
1932	0.02	0.08	0.19	00.70
1933	0.02	0.10	0.15	00.85
1934	0.02	0.12	0.19	1.04
1935	0.03	0.15	0.25	1.29
1936	0.03	0.18	0.35	1.64
1937	0.03	0.21	0.28	1.92
1938	0.03	0.24	0.25	2.17
1939	0.03	0.27	0.26	2.43
1940	0.03	0.30	0.26	2.69
1941, 1st ½	0.02	0.32	0.10	2.79
1941, 2nd ½	0.01	0.33	0.02	2.81
1942	0.01	0.34	0.05	2.86
1943	0.01	0.35	0.05	2.91
1944	0.02	0.37	0.08	2.99
1945	0.02	0.39	0.11	3.10
1946	0.03	0.42	0.15	3.25
1947	0.03	0.45	0.14	3.39
1948	0.04	0.49	0.20	3.59
1949	0.04	0.53	0.30	3.89
1950	0.06	0.59	0.34	4.23
1951	0.06	0.65	0.39	4.62
1952	0.06	0.71	0.46	5.08
1953	0.07	0.78	0.50	5.58
1954	0.08	0.86	0.56	6.14
1955	0.09	0.95	0.60	6.74
1956	0.11	1.06	0.62	7.36
1957	0.12	1.18	0.61	7.97
1958	0.14	1.32	0.65	8.62
1959	0.15	1.47	0.73	9.35
1960	0.16	1.63	0.83	10.18
1961	0.18	1.81	0.82	11.00
1962	0.19	2.00	0.85	11.85
1963	0.21	2.21	0.89	12.74
1964	0.23	2.44	0.93	13.67
1965	0.24	2.68	0.62	14.29
1966	0.26	2.94	1.05	15.34

Source: Columns 1 and 2: 2½% annual rate applied to table A-2, Column 3, p. 387 in MP and table A-2-X, Column 3, p. 32 in BMP. Columns 3 and 4: 2% annual rate applied to Table 1-C, Column 4.

TABLE 11

INDUSTRIAL PRODUCTION INDEX COMPONENTS
(1937 = 100)

Year	Civilian Industry	Munitions Industry	Construction	Transportation and Communications	Trade and Restaurants
1928	40.2	4.0	36.7	27.9	91.8
1929	46.4	5.0	45.0	34.0	97.1
1930	55.3	6.0	58.9	43.6	99.2
1931	59.4	6.0	63.7	50.3	98.4
1932	61.7	6.0	63.6	58.1	78.0
1933	65.0	16.0	57.2	56.5	66.6
1934	73.5	35.0	69.1	63.8	71.7
1935	84.8	60.0	85.3	75.1	74.2
1936	98.1	80.0	115.0	90.2	86.4
1937	100.0	100.0	100.0	100.0	100.0
1938	101.6	145.0	98.8	102.0	109.1
1939	105.0	205.0	101.0	108.9	123.5
1940	105.6	280.0	101.0	115.1	106.6
1941	110.3		65.8	104.6	99.4
1942	75.4		30.7	59.5	44.2
1943	83.4		32.0	67.6	45.4
1944	92.3		41.7	77.7	56.8
1945	54.3	420.0	42.9	83.2	68.0
1946	67.4	275.0	64.2	95.0	76.1
1947	82.6	245.0	79.4	99.3	72.0
1948	106.4	230.0	106.0	118.2	79.6
1949	129.4	230.0	135.0	136.0	100.2
1950	148.4	240.0	155.0	155.6	130.5
1951	167.4	285.0	176.0	175.6	146.1
1952	177.5	315.0	196.0	192.9	157.6
1953	195.1	300.0	217.0	208.2	184.9
1954	218.7	320.0	239.0	225.1	214.8
1955	243.4	360.0	264.0	254.4	223.0
1956	272.1	370.0	277.0	279.6	239.4
1957	296.2	380.0	301.0	314.6	271.0
1958	325.1	395.0	337.0	340.6	285.7
1959	350.7	400.0	377.0	373.4	303.6
1960	369.7	475.0	405.0	395.5	330.0
1961	392.4	580.0	424.0	419.6	341.9
1962	417.4	645.0	445.0	447.3	361.8
1963	444.4	670.0	459.0	485.3	376.8
1964	474.6	655.0	478.0	530.0	396.1
1965	507.6	666.0	504.0	579.9	434.1
1966	538.6	705.0	533.0	615.6	471.9

Sources: 1928-1940, 1945-1960: MP, pp. 622-24; 1941-1944; P, p. 31; 1961-1966: BMP, p. 51.

TABLE 12

LABOR FORCE BY SECTOR
(Millions)

Year	Industry	Construc-tion	Transpor-tation Communica-tions	Retail Trade	Forestry
1928	3.773	0.723	1.365	0.532	0.075
1929	3.944	0.898	1.417	0.627	0.081
1930	5.069	1.459	1.619	0.815	0.087
1931	6.738	2.029	2.010	1.078	0.093
1932	8.000	2.289	2.241	1.411	0.100
1933	7.796	1.804	2.387	1.375	0.120
1934	8.179	1.971	2.659	1.465	0.144
1935	8.877	1.699	3.054	1.650	0.172
1936	9.495	1.638	3.039	(2.037)	0.207
1937	10.112	1.576	3.026	2.525	0.248
1938	10.218	1.521	3.605	(2.700)	0.258
1939	10.324	1.586	3.773	(2.888)	0.268
1940	10.967	1.563	3.903	3.303	0.279
1945	9.508	1.515	3.537	2.440	0.199
1946	11.449	1.852	3.952	(2.596)	0.234
1947	12.444	2.062	4.162	(2.762)	0.274
1948	12.849	2.223	4.320	(2.939)	0.322
1949	13.568	2.414	4.509	(3.127)	0.378
1950	14.144	2.569	4.624	3.325	0.444
1951	15.006	2.678	4.899	3.409	0.453
1952	15.556	2.788	5.160	3.495	0.462
1953	16.261	2.843	5.352	3.463	0.416
1954	17.016	3.179	5.536	3.591	0.402
1955	17.367	3.190	5.650	3.725	0.389
1956	18.500	3.550	5.840	3.826	0.390
1957	19.144	4.000	5.996	4.017	0.377
1958	19.675	4.421	6.332	4.190	0.367
1959	20.207	4.800	6.663	4.389	0.352
1960	22.291	5.143	7.017	4.675	0.359
1961	23.475	5.270	7.308	5.010	0.378
1962	24.297	5.172	7.509	5.253	0.389
1963	25.057	5.237	7.718	5.487	0.399
1964	25.933	5.370	7.982	5.752	0.404
1965	27.056	5.617	8.259	6.009	0.402
1966	28.105	5.768	8.437	6.261	0.409

TABLE 12--Continued

Year	Producers Co-ops	Inde-pendent Artisans	Industrial work in agriculture	Other and residual	Total
1928	0.605	1.700	0.208	0.075	9.101
1929	0.900	1.500	0.197	0.088	9.652
1930	1.200	1.100	0.194	0.103	11.646
1931	1.400	0.900	0.258	0.120	14.626
1932	1.600	0.800	0.369	0.140	16.950
1933	1.400	0.700	0.352	0.155	16.089
1934	1.400	0.600	0.309	0.170	16.897
1935	1.700	0.500	0.297	0.186	18.135
1936	1.500	0.500	0.270	0.205	18.891
1937	1.800	0.500	0.261	0.225	20.273
1938	1.800	0.500	0.240	0.256	21.098
1939	1.900	0.500	0.255	0.291	21.785
1940	2.734	0.604	0.270	0.331	23.954
1945	1.300	0.225	0.273	0.250	19.247
1946	1.400	0.232	0.285	0.307	22.307
1947	1.400	0.240	0.299	0.351	23.994
1948	1.400	0.248	0.312	0.394	25.007
1949	1.400	0.256	0.328	0.444	26.424
1950	1.525	0.264	0.344	0.503	27.742
1951	1.600	0.246	0.355	0.537	29.183
1952	1.600	0.230	0.369	0.563	30.223
1953	1.600	0.214	0.403	0.600	31.152
1954	1.700	0.187	0.600	0.632	32.843
1955	1.800	0.164	0.554	0.665	33.504
1956	1.200	0.195	0.610	0.673	34.784
1957	1.200	0.145	0.747	0.699	36.325
1958	1.400	0.156	0.620	0.764	37.925
1959	1.400	0.174	0.584	0.903	39.472
1960		0.174	0.641	1.019	41.319
1961		0.174	0.784	1.102	43.501
1962		0.174	0.820	1.158	44.772
1963		0.087	0.834	1.228	46.047
1964			0.855	1.319	47.615
1965			0.917	1.426	49.686
1966			1.250	1.475	51.705

Source: Retail Trade, 1928-1935: Kaplan, Earnings Distributions in the USSR, The RAND Corporation, RM-6170, 1969, p. 133. All data, 1928-1965: Kaplan, The Record of Soviet Economic Growth, 1928-1965, The RAND Corporation, RM-6169, pp. 209-10. All data, 1966: Weitzman, Soviet Postwar Economic Growth and Capital Labor Substitution, Cowles Foundation Discussion Paper No. 256, 1968, pp. 39-40. For explanation of Producers Co-ops, Independent Artisans, Industrial work in Agriculture and Others and Residual as well as figures in parentheses see text and Table 10.

TABLE 13

INDUSTRIAL WORK IN AGRICULTURE
(Millions)

Year	Agricultural Labor Force	Industrial Work in Agriculture (%)
1928	1.660	(12.5)
1929	1.576	(12.5)
1930	1.552	(12.5)
1931	2.060	(12.5)
1932	2.948	(12.5)
1933	2.819	(12.5)
1934	3.094	(10.0)
1935	2.974	(10.0)
1936	2.700	(10.0)
1937	2.609	9.0
1938	2.400	(10.0)
1939	2.547	(10.0)
1940	2.697	10.0
1945	2.731	(10.0)
1946	2.852	(10.0)
1947	2.988	(10.0)
1948	3.122	(10.0)
1949	3.276	(10.0)
1950	3.437	10.0
1951	3.554	(10.0)
1952	3.693	(10.0)
1953	4.026	10.0
1954	5.999	(10.0)
1955	6.157	9.0
1956	6.095	10.0
1957	6.793	11.0
1958	6.195	10.0
1959	5.838	10.0
1960	7.123	9.0
1961	7.838	(10.0)
1962	8.197	(10.0)
1963	8.339	(10.0)
1964	8.552	(10.0)
1965	9.167	(10.0)
1966	.....	(10.0)

Source: Column 1: see Table 9. Column 2: MP, p. 645 and text.

TABLE 14

MAN HOURS PER YEAR: LARGE SCALE INDUSTRIAL LABOR FORCE

Year	Actual Days Worked	Average Hours Per Day	Average Hours Per Year	Man Hours Per Year (billions)
1928	263.0	7.37	1938.31	17.64
1929	264.2	7.37	1947.15	18.79
1930	252.7	7.38	1864.93	21.72
1931	253.2	7.26	1838.23	26.89
1932	257.2	7.16	1841.55	31.21
1933	265.8	7.11	1889.84	30.41
1934	267.0	7.09	1893.03	31.99
1935	268.0	7.06	1892.08	34.31
1936	264.1	7.00	1848.70	34.92
1937	260.3	7.00	1822.10	36.94
1938	260.3	7.00	1822.10	38.44
1939	260.3	7.00	1822.10	39.69
1940	269.8	8.00	2158.40	51.70
1945	292.0	8.50	2482.00	47.77
1946	284.0	8.00	2272.00	50.68
1947	276.3	8.00	2210.40	53.04
1948	276.3	8.00	2210.40	55.28
1949	276.3	8.00	2210.40	58.41
1950	276.3	8.00	2210.40	61.32
1951	275.6	8.00	2204.80	64.34
1952	274.8	8.00	2198.40	66.44
1953	274.3	8.00	2194.40	68.36
1954	273.8	8.00	2194.40	72.07
1955	273.3	8.00	2186.40	73.25
1956	272.1	7.70	2095.17	72.88
1957	267.4	7.64	2042.94	74.21
1958	268.0	7.54	2020.72	76.64
1959	266.5	7.37	1964.11	77.53
1960	266.9	6.99	1865.63	77.09
1961	264.2	6.67	1762.21	76.66
1962	263.4	6.67	1756.88	78.66
1963	264.5	6.67	1764.22	81.24
1964	266.5	6.67	1777.56	84.64
1965	266.4	6.67	1776.89	88.29
1966	263.1	6.67	1754.88	90.74

Source: Columns 1-3: Kaplan, The Record of Soviet Economic Growth, 1928-1965, The RAND Corporation, RM-6169, 1969, p. 217. Column 4: Column 10, Table 9 times Column 3 above.

TABLE 15

DISTRIBUTION OF MEMBERS OF PRODUCERS CO-OPS AMONG OTHER SECTORS (MILLIONS)

Year	Industry	Construc-tion	Transpor-tation	Communica-tions	Trade
1928	0.518	0.013	0.016	0.002	0.012
1929	0.771	0.019	0.024	0.003	0.018
1930	1.028	0.026	0.032	0.004	0.024
1931	1.200	0.030	0.037	0.004	0.028
1932	1.371	0.035	0.042	0.005	0.032
1933	1.200	0.030	0.037	0.004	0.028
1934	1.200	0.030	0.037	0.004	0.028
1935	1.457	0.037	0.045	0.005	0.034
1936	1.286	0.032	0.040	0.005	0.030
1937	1.543	0.039	0.048	0.006	0.036
1938	1.543	0.039	0.048	0.006	0.036
1939	1.628	0.041	0.050	0.006	0.038
1940	2.341	0.059	0.072	0.008	0.054
1945	1.114	0.028	0.034	0.004	0.026
1946	1.200	0.030	0.037	0.004	0.028
1947	1.200	0.030	0.037	0.004	0.028
1948	1.200	0.030	0.037	0.004	0.028
1949	1.200	0.030	0.037	0.004	0.028
1950	1.307	0.033	0.040	0.005	0.030
1951	1.371	0.035	0.042	0.005	0.032
1952	1.371	0.035	0.042	0.005	0.032
1953	1.371	0.035	0.042	0.005	0.032
1954	1.457	0.037	0.045	0.005	0.034
1955	1.543	0.039	0.048	0.006	0.036
1956	1.028	0.026	0.032	0.004	0.024
1957	1.028	0.026	0.032	0.004	0.024
1958	1.200	0.030	0.037	0.004	0.028
1959	1.200	0.030	0.037	0.004	0.026

Source: See Table 9 and text.

TABLE 16

SECTORAL LABOR FORCE: ADJUSTED
(MILLIONS)

Year	Industry	Construc-tion	Trans-portation	Communi-cations
1928	4.291	0.736	1.286	0.097
1929	4.715	0.917	1.321	0.123
1930	6.097	1.485	1.498	0.157
1931	7.938	2.059	1.850	0.201
1932	9.371	2.324	2.059	0.229
1933	8.996	1.834	2.166	0.262
1934	9.379	2.001	2.401	0.299
1935	10.344	1.736	2.765	0.339
1936	10.781	1.670	2.725	0.359
1937	11.655	1.615	2.699	0.381
1938	11.761	1.560	3.214	0.445
1939	11.952	1.627	3.370	0.459
1940	13.308	1.622	3.497	0.486
1945	10.622	1.543	3.145	0.430
1946	12.649	1.882	3.521	0.472
1947	13.644	2.092	3.713	0.490
1948	14.049	2.253	3.858	0.503
1949	14.768	2.444	4.031	0.510
1950	15.451	2.602	4.122	0.547
1951	16.377	2.713	4.382	0.564
1952	16.927	2.823	4.637	0.570
1953	17.632	2.878	4.812	0.587
1954	18.473	3.216	4.986	0.600
1955	18.910	3.229	5.087	0.617
1956	19.528	3.576	5.248	0.628
1957	20.172	4.026	5.387	0.645
1958	20.875	4.451	5.705	0.688
1959	21.407	4.830	6.009	0.695
1960	22.291	5.143	6.279	0.738
1961	23.475	5.270	6.518	0.790
1962	24.297	5.172	6.677	0.832
1963	25.057	5.237	6.841	0.877
1964	25.933	5.370	7.054	0.928
1965	27.056	5.617	7.252	1.007
1966	28.105	5.768	7.364	1.073

TABLE 16--Continued

Year	Trade	Industrial work in agriculture and forestry	Independent Artisans and Other, Residual
1928	0.544	0.283	1.775
1929	0.645	0.278	1.588
1930	0.839	0.281	1.203
1931	1.106	0.351	1.020
1932	1.443	0.469	0.940
1933	1.403	0.472	0.855
1934	1.493	0.453	0.770
1935	1.684	0.469	0.686
1936	2.067	0.477	0.705
1937	2.561	0.509	0.725
1938	2.736	0.498	0.756
1939	2.926	0.523	0.791
1940	3.357	0.540	0.935
1945	2.466	0.472	0.475
1946	2.624	0.519	0.539
1947	2.790	0.573	0.591
1948	2.967	0.634	0.642
1949	3.155	0.706	0.700
1950	3.355	0.788	0.767
1951	3.441	0.808	0.783
1952	3.527	0.831	0.793
1953	3.495	0.819	0.814
1954	3.625	1.002	0.819
1955	3.761	0.943	0.829
1956	3.850	1.000	0.868
1957	4.041	1.124	0.844
1958	4.218	0.987	0.920
1959	4.417	0.936	1.077
1960	4.675	1.000	1.193
1961	5.010	1.162	1.276
1962	5.253	1.209	1.332
1963	5.487	1.223	1.315
1964	5.752	1.259	1.319
1965	6.009	1.319	1.426
1966	6.261	1.659	1.475

Source: Table 9 and Table 12.

TABLE 17

AVERAGE MONTHLY EARNINGS BY SECTOR
(RUBLES)

Year	Industry	Construction	Transportation	Communications
1928	7.0	8.3	7.2	6.5
1929	7.8	8.5	7.7	6.0
1930	8.5	9.0	8.9	6.3
1931	9.8	10.4	10.0	8.6
1932	12.2	12.6	12.6	11.1
1933	13.8	13.7	13.9	12.1
1934	15.9	17.0	16.3	13.1
1935	19.5	20.8	19.9	16.2
1936	(22.1)	(22.9)	(22.2)	(18.1)
1937	25.0	(25.3)	(24.9)	(20.2)
1938	(27.7)	(27.9)	(27.8)	(22.5)
1939	(30.7)	(30.7)	(31.1)	(25.1)
1940	34.0	33.9	34.7	28.1
1945	47.0	41.3	48.2	35.4
1946	(51.4)	(44.5)	(52.0)	(38.3)
1947	(56.1)	(48.0)	(56.1)	(41.5)
1948	61.4	(51.7)	(60.5)	(45.0)
1949	(65.7)	(55.8)	(65.3)	(48.7)
1950	70.3	60.1	70.5	52.7
1951	71.8	(62.7)	(71.8)	(53.3)
1952	73.5	(65.4)	(73.1)	(53.9)
1953	75.0	(68.2)	(74.4)	(54.5)
1954	76.8	(71.1)	(75.7)	(55.1)
1955	78.3	74.2	77.0	55.6
1956	(81.1)	(78.2)	(78.8)	(56.4)
1957	(84.0)	(82.4)	(80.6)	(57.2)
1958	87.1	86.7	82.3	58.0
1959	89.4	88.5	84.1	58.4
1960	91.3	91.7	86.7	62.3
1961	94.5	96.8	93.1	70.6
1962	96.6	99.3	97.5	71.9
1963	98.4	101.6	99.3	72.5
1964	100.5	106.0	102.2	73.3
1965	103.3	109.4	105.5	73.9
1966	106.8	113.1	109.6	75.4

TABLE 17--Continued

Year	Trade	Forestry	Industrial work in agriculture	Independent Artisans, Other, residual
1928	6.5	3.3	2.4	5.6
1929	6.7	4.1	3.0	6.7
1930	7.4	4.1	4.6	7.8
1931	8.9	6.8	6.6	9.4
1932	11.3	9.1	7.2	11.7
1933	11.2	9.5	8.7	12.9
1934	12.4	11.5	10.2	15.0
1935	15.4	12.7	13.1	18.4
1936	(16.9)	(14.2)	(14.5)	(20.7)
1937	(18.6)	(15.8)	(16.1)	(23.2)
1938	(20.5)	(17.6)	(17.8)	(26.1)
1939	(22.5)	(19.6)	(19.7)	(29.4)
1940	25.0	21.9	21.9	33.0
1945	26.9	21.3	21.3	43.4
1946	(30.1)	(23.9)	(23.9)	(46.9)
1947	(33.6)	(26.9)	(26.9)	(50.7)
1948	(37.6)	(30.2)	(30.2)	(54.7)
1949	(42.0)	(34.0)	(34.0)	(59.2)
1950	46.9	38.2	38.2	63.9
1951	(47.9)	(39.7)	(39.7)	(65.4)
1952	(49.0)	(41.4)	(41.4)	(66.9)
1953	(50.1)	(43.0)	(43.0)	(68.4)
1954	(51.2)	(44.8)	(44.8)	(70.0)
1955	52.3	46.6	46.6	71.5
1956	(54.2)	(48.7)	(48.7)	(73.6)
1957	(56.1)	(50.8)	(50.8)	(75.7)
1958	58.1	53.1	53.1	77.8
1959	58.3	54.6	54.6	78.9
1960	58.6	53.9	53.9	80.1
1961	61.0	58.0	58.0	83.4
1962	63.6	66.1	66.1	86.2
1963	64.5	67.1	67.1	86.7
1964	65.7	70.6	70.6	90.1
1965	74.9	74.5	74.5	95.6
1966	79.3	79.8	79.8	99.2

Source: Narkhoz, 1965; Narkhoz, 1967; Strana Sovetob za 50 Let, 1958; Trud v SSSR, 1955; Bergson, The Real National Income of Soviet Russia Since 1928, 1961; Kaplan, Earnings Distributions in the USSR, 1970; Joint Economic Committee, Economic Performance and the Military Burden in the Soviet Union, 1970. See also text descriptions.

TABLE 18

AVERAGE ANNUAL EARNINGS: BY SECTOR AND TOTAL
(MILLION RUBLES)

Year	Industry	Construc-tion	Transpor-tation	Communica-tions	Trade
1928	84.0	99.6	86.4	78.0	78.0
1929	93.6	102.0	92.4	72.0	80.4
1930	102.0	108.0	106.8	75.6	88.8
1931	117.6	124.8	120.0	103.2	106.8
1932	146.4	151.2	151.2	133.2	135.6
1933	165.6	164.4	166.8	145.2	134.4
1934	190.8	204.0	195.6	157.2	148.8
1935	234.0	249.6	238.8	194.4	184.8
1936	265.2	274.8	266.4	217.2	202.8
1937	300.0	303.6	298.8	242.4	223.2
1938	332.4	334.8	333.6	270.0	246.0
1939	368.4	368.4	373.2	301.2	270.0
1940	408.0	406.8	416.4	337.2	300.0
1945	564.0	495.6	578.4	424.8	322.8
1946	616.8	534.0	624.0	459.6	361.2
1947	673.2	576.0	673.2	498.0	403.2
1948	736.8	620.4	726.0	540.0	451.2
1949	788.4	669.6	783.6	584.4	504.0
1950	843.6	721.2	846.0	632.4	562.8
1951	861.6	752.4	861.6	639.6	574.8
1952	882.0	784.8	877.2	646.8	588.0
1953	900.0	818.4	892.8	654.0	601.2
1954	921.6	853.2	908.4	661.2	614.4
1955	939.6	890.4	924.0	667.2	627.6
1956	973.2	938.4	945.6	676.8	650.4
1957	1008.0	988.8	967.2	686.4	673.2
1958	1045.2	1040.4	987.6	696.0	697.2
1959	1072.8	1062.0	1009.2	700.8	699.6
1960	1095.6	1100.4	1040.4	747.6	703.2
1961	1134.0	1161.6	1117.2	847.2	732.0
1962	1159.2	1191.6	1170.0	862.8	763.2
1963	1180.8	1219.2	1191.6	870.0	774.0
1964	1206.0	1272.0	1226.4	879.6	788.4
1965	1239.6	1312.8	1266.0	886.8	898.8
1966	1281.6	1357.2	1315.2	904.8	951.6

TABLE 18--Continued

Year	Forestry	Industrial work in agriculture	Other, Residual	Average: all sectors
1928	39.6	28.8	67.2	79.44
1929	49.2	36.0	80.4	88.68
1930	49.2	55.2	93.6	99.12
1931	81.6	79.2	112.8	115.80
1932	109.2	86.4	140.4	143.64
1933	114.0	104.4	154.8	159.24
1934	138.0	122.4	180.0	185.16
1935	152.4	157.2	220.8	226.80
1936	170.4	174.0	248.4	244.92
1937	189.6	193.2	278.4	283.68
1938	211.2	213.6	313.2	281.04
1939	235.2	236.4	352.8	348.24
1940	262.8	262.8	396.0	385.32
1945	255.6	255.6	520.8	515.40
1946	286.8	286.8	562.8	656.56
1947	322.8	322.8	608.4	616.80
1948	362.4	362.4	656.4	671.88
1949	408.0	408.0	710.4	723.12
1950	458.4	458.4	766.8	777.36
1951	476.4	476.4	784.8	797.04
1952	498.8	498.8	802.8	816.96
1953	516.0	516.0	820.8	837.36
1954	537.6	537.6	840.0	856.80
1955	559.2	559.2	858.0	876.00
1956	584.4	584.4	883.2	911.04
1957	609.6	609.6	908.4	939.72
1958	637.2	637.2	933.6	974.76
1959	655.2	655.2	946.8	997.08
1960	646.9	646.9	961.2	1022.16
1961	696.0	696.0	1000.8	1067.40
1962	793.2	793.2	1034.4	1098.72
1963	805.2	805.2	1040.4	1117.80
1964	847.2	847.2	1081.2	1146.48
1965	894.0	894.0	1147.2	1191.12
1966	957.6	957.6	1190.4	1233.72

Source: Table 14 and text.

TABLE 19

INDEXES OF OUTPUT, CAPITAL, LABOR AND ANNUAL WAGES FOR INDUSTRY (1937 = 100)

Year	Output	Capital	Labor	Wages
1928	41.29	22.13	47.75	28.00
1929	47.34	25.85	50.87	31.26
1930	55.80	31.78	58.80	34.97
1931	59.70	34.06	72.79	40.82
1932	60.25	47.89	84.49	50.63
1933	60.61	55.66	82.32	56.13
1934	69.42	63.31	86.60	65.27
1935	81.00	72.88	92.88	79.95
1936	96.47	85.97	94.53	86.34
1937	100.00	100.00	100.00	100.00
1938	104.24	113.29	104.06	99.06
1939	111.95	126.38	107.44	122.76
1940	115.24	139.14	139.96	135.83
1945	76.97	142.17	129.32	181.68
1946	82.52	153.91	137.20	199.37
1947	91.80	165.15	143.58	217.43
1948	111.57	177.96	149.65	236.84
1949	132.98	193.87	158.12	254.91
1950	152.88	213.46	166.00	274.03
1951	173.17	236.16	174.17	280.96
1952	186.55	259.84	179.86	287.99
1953	203.52	285.93	185.06	295.18
1954	226.33	316.24	195.10	302.03
1955	250.89	351.66	198.29	308.80
1956	275.27	394.44	197.29	321.15
1957	301.21	441.72	200.89	331.26
1958	328.25	493.70	207.47	343.61
1959	354.72	554.76	209.88	351.48
1960	378.60	614.15	208.69	360.32
1961	404.05	687.36	207.53	376.27
1962	430.51	762.99	212.94	387.31
1963	456.67	843.89	219.92	394.04
1964	484.80	931.00	229.13	404.15
1965	519.28	1018.28	239.01	419.88
1966	551.92	1109.73	245.64	434.90

Source: Tables 8, 4-B, 11 and 15.

APPENDIX B

This appendix presents postwar (1950-1972) indexes of output, capital stock, man-hours, and average wages for Soviet industry. Unlike the indexes presented in Appendix A, official Soviet sources are relied upon exclusively. Since the death of Stalin, the Soviets have become much less reticent about releasing statistical materials. Since 1956, annual national economy handbooks (Narodno khoziastvo SSSR) have been published, two volumes on industry (Promyshlennost' SSSR) appeared in 1956 and 1964, a volume on labor and wages (Trud v SSSR) was published in 1968 and several Soviet journals now include statistical material on a more-or-less regular basis.[1] Quantity is not, however, a substitute for quality; Soviet statistical materials are deficient in many respects. Therefore before proceeding to the derivation of the industry indexes, a discussion of the shortcomings of these data is in order.

Output

Industrial output is obtained from the official gross value of output (GVO) series presented in all handbooks. The GVO index values the output of all industrial

[1]Michael Kaser, "The Publication of Soviet Statistics," in Soviet Economic Statistics, ed. by Vladimir G. Treml and John P. Hardt (Durham: Duke University Press, 1972), p. 59.

enterprises in constant prices. The base year in the constant price calculations has changed several times during the postwar period and these changes are shown in Table 1.

TABLE 1

GVO INDEX PRICE BASES

Year Covered	Price Base
1949-1951	Current Wholesale Prices
1952-1955	January 1, 1952 Prices
1955-1967	July 1, 1955 Prices
1968-1972	July 1, 1967 Prices

Source: Rush V. Greenslade, "Industrial Production Statistics in the USSR," in Soviet Economic Statistics, ed. by Vladimir G. Treml and John P. Hardt (Durham: Duke University Press, 1972), p. 171.

Shifting the base year from the 1926/1927 pre-industrial base used until 1949 has greatly reduced the problem of index number relativity, but major shortcomings in the GVO indexes remain. The enterprise classification leads to the double-counting of inter-enterprise purchases. Furthermore, the extent of this double counting changes as enterprises integrate or dis-integrate vertically. This overstating of output is compounded by the inclusion in output of semiprocessed inventories, repair work done on equipment and structures and certain expenditures relating to the development of new products. Finally, new product pricing may, in certain industries, lead to substantial

upward bias in the value of output.[2] Despite these limitations, the GVO indexes exhibit the same basic output trends as do Western recalculations based on value-weighted sample indexes constructed from official physical output series.[3]

Labor

In selecting a labor input series, the choices are generally an index of the number of workers, an index of man-years or an index of man-hours. Because of the marked decline in working hours after 1956, use of the number of workers must be ruled out. The use of man-years implicitly assumes that labor productivity per man year is constant; constancy of productivity per man-hour is implicit in man-hour calculations. While neither assumption is, in the strictest sense, correct, Kaplan states that "If I must choose between the two assumptions, I prefer the second [man-hours] . . . ,"[4] and in this study an index of man-hours per year is used.

Man-hours per year are obtained by multiplying the number of workers by the number of days worked and the number of hours worked per day. The number of industrial

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[2] Rush V. Greenslade, "Industrial Production Statistics in the Soviet Union," in Ibid., pp. 171-86.

[3] On the problems of using official physical output series see Gregory Grossman, Soviet Statistics on Physical Output of Industrial Commodities (Princeton: Princeton University Press, 1960).

[4] Norman H. Kaplan, The Record of Soviet Economic Growth, 1928-1965, The RAND Corporation, RM-6169, p. 19.

workers recorded in Soviet handbooks understates total industrial employment as recorded in U. S. statistical data. Non-production personnel such as plant doctors, trainees under 18 years of age and kolkhozniks (farmers) working part-time in industrial plants are all excluded. However, the number of hours worked per year is overstated by the Soviet method of reporting work-time. Each worker reporting for work is counted as having worked an entire day whether this is so or not. And because calendar days rather than work days are used, frictional unemployment due to job turnover is not recorded. Finally, the hours of work scheduled rather than the hours actually worked are used, again imparting an upward bias to total manhours.[5] These limitations are not inconsequential but for this study no attempt at adjustment is made as no international comparisons are to be made.

Wages

The average annual wage index is taken directly from average monthly wages by sector given in Soviet handbooks and multiplied by twelve. Average monthly wages are determined by dividing the wage fund by the number of registered staff. The composition of this wage fund is as follows:

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[5] Murray Feshbach, "Soviet Industrial Labor and Productivity Statistics," in Soviet Economic Statistics, pp. 198-99.

> The wage fund includes all regular wages and salaries paid in accordance with established rates and scales, all regular bonuses paid to production workers in connection with the operation of the established wage and salary system, all supplemental wage payments (such as severance pay) provided for by law, and the money value of goods and services-in-kind required by law to be provided in some cases.[6]

Two major problems affect the consistency of Soviet data on average wages. First, the denominator (registered staff) suffers from the same problems of definition discussed above in conjunction with the labor inputs. Second, since the 1965 economic reform certain bonuses are included in the wage fund that were not previously included. The Soviets have published revised wage figures beginning with 1960 but prior to this certain adjustments must be made in the published wage data to insure consistency.[7]

Capital

Capital stock data are obtained from the series Tempy Rosta Osnovykh Fondov (Growth Rate of Basic Funds) given in all Soviet handbooks. This series gives the December 31 ruble value of the gross industrial capital stock in mid-1955 prices as an index in which 1940 = 100. The use of this official series precludes any calculation of capital services such as that used in Appendix A for two reasons. First, data on profits are not generally thought of as yielding a rate of return on capital due to the

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[6] Gertrude E. Schroeder, "An Appraisal of Soviet Wage and Income Statistics," in Ibid., p. 292.

[7] Ibid., p. 293.

anomolies of Soviet pricing. Second, depreciation charges are abnormally low and have little relation to the actual service lives of machinery and equipment.

Whether the series on capital stock overstates or understates the more desirable index of capital services is uncertain. As the average age of Soviet equipment decreases, capital stock data probably understate the actual services of capital. On the other hand, the pricing of new equipment and the lack of adjustment for capacity utilization both tend to overstate the services of capital.[8] Because there is no way to judge the extent to which these conflicting tendencies offset one another, the series is used as it stands. Mid-year values are derived by the same formula employed in Appendix A.

The data presented in the following tables updates the data in Weitzman's study,[9] which drew exclusively on Soviet sources, with two exceptions. First, the wage index extends through 1972 a similar index presented in Appendix A. Second, in addition to the value added weights presented by Weitzman, official Soviet GVO weights are also used in obtaining the industrial output index. The major difference in the two weighting procedures lies in the use of turnover taxes in the calculation of official GVO weights. Turnover taxes are imposed almost exclusively in the light

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[8] Weitzman, "Postwar Soviet Economic Growth," pp. 688-89.

[9] Ibid., p. 677.

and food industries. Consequently the GVO weights for these two industries are considerably higher than the value added weights used by Weitzman.

TABLE 2

A COMPARISON OF SOVIET AND WESTERN INDUSTRIAL GVO WEIGHTS, 1960, PER CENT

Sector	Soviet	Western
Electric Power	2.4	5.01
Fuels	5.0	14.73
Ferrous Metals	5.6	7.47
Nonferrous Metals	2.6	3.70
Forrestry, Wood and Paper	6.1	9.84
Construction	4.3	6.42
Chemicals	4.3	4.36
Machine Building and Metal Working	21.9	28.89
Glass and Porcelain	0.6	0.82
Light Industry	24.4	10.35
Food Industry	22.8	8.41
Total	100.0	100.00

Source: Weitzman, "Postwar Soviet Economic Growth," p. 690 and Stanley H. Cohn, "National Income Growth Statistics," in Soviet Economic Statistics ed. by Vladimir G. Treml and John P. Hardt, p. 192.

TABLE 3

INDEXES OF OUTPUT, CAPITAL, LABOR AND WAGES FOR SOVIET INDUSTRY, 1950-72[c]

Year	Output[a]	Output[b]	Capital	Labor	Wages
1950	35.22	33.15	33.76	79.92	77.00
1951	40.93	38.20	37.59	84.52	78.64
1952	45.24	42.56	42.34	87.60	80.50
1953	50.43	47.35	46.95	91.41	82.15
1954	56.95	53.46	52.18	95.83	84.12
1955	63.07	60.34	58.64	97.61	85.76
1956	69.16	66.33	65.63	96.32	88.83
1957	75.52	73.01	72.50	96.60	92.00
1958	82.93	81.29	80.44	99.14	95.40
1959	91.86	90.56	89.66	100.66	97.92
1960	100.00	100.00	100.00	100.00	100.00
1961	108.40	109.56	111.58	99.54	103.50
1962	118.27	120.27	123.93	102.81	105.81
1963	127.15	131.21	138.09	106.44	107.78
1964	135.49	141.78	154.29	110.91	110.08
1965	146.45	153.41	170.42	115.65	113.14
1966	158.97	167.09	186.12	118.66	116.98
1967	174.84	183.65	201.72	122.55	124.21
1968	190.05	200.01	217.67	126.62	133.52
1969	203.90	215.49	236.68	129.67	139.87
1970	221.83	235.04	259.09	131.47	146.00
1971	239.83	255.23	283.11	133.29	151.04
1972	255.93	275.15	305.56	136.76	156.30

[a]Soviet Weights

[b]Western weights

[c]1960 = 100

Sources: Weitzman, "Postwar Soviet Economic Growth," p. 677; Narkhoz, 1970, pp. 60, 510; Narkhoz, 1922-1972, pp. 60, 148, 346, 350; Pravda, January 30, 1972, pp. 1-3.

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