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SOVIET TRANSPORT AND COMMUNICATIONS: OUTPUT INDEXES, 1928-1962

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PREFACE

This Project RAND Memorandum is part of the RAND Corporation's continuing study of Soviet economic growth and the economic basis of Soviet military strength. It provides an output index for a sector of the economy--transport and communications--the aggregate performance of which has not been measured heretofore. By comparisons between output and input increases in transport and communications, and by comparisons between the United States and the Soviet Union in this and other respects, it represents an initial and tentative effort to assess the role of the sector in overall economic growth. Related studies published by RAND include Abram Bergson's The Real National Income of Soviet Russia Since 1928 (R-367-PR, 1961) and A. S. Becker's Soviet Military Outlays Since 1955 (RM-3886-PR, June 1964).

The results of the present Memorandum are intended to be useful to investigators in three areas: (1) to specialized students of Soviet transport and communications for whom this is the first output index available, (2) to students of Soviet economic growth who wish to construct an index of national product by sector of origin or who wish to know whether and to what extent recent conclusions about a deceleration of the overall Soviet growth rate hold also for specific sectors of the economy, and (3) to students of aggregate production functions who are concerned with the impact of sector functions on the aggregate.

SUMMARY

In this study output indexes are constructed for transport and communications and separately for transport, communications, freight transport, passenger transport, and railroad transport. For transport, output series in ton- or passenger-kilometers by types of carrier are aggregated with 1955 cost weights. A communications output index is obtained from ruble output and employment data and is combined with the transport index by ruble output weights to form an index for the sector as a whole. The effect of alternative weighting systems is examined and is shown to be relatively unimportant.

Intertemporal comparisons of the growth rates implied by the indexes show post-1950 growth rates that are generally below those in 1928-1937 or 1928-1940 and generally above those in 1932-1937 or 1932-1940. Within the post-1950 period, comparisons show a marked tendency for the 1958-1962 growth rates to decrease as against those for 1950-1958 or 1953-1958.

Comparisons between the USSR growth rates and those for the United States indicate that in general the rates of increase of output for Soviet transport and communications and their major components greatly exceed those in the United States from 1869 to date.

Comparisons between the Soviet increase in transport and communications output and the increases in labor and capital inputs reveal that the output increase exceeds the combined inputs increase and each of the input increases considered separately. United States data for the same sector show the same inequalities. Although the average capital-output ratio for the USSR has continued to decline over time, the incremental capital-output ratio in recent years has increased markedly after earlier declines.

CONTENTS

PREFACE iii

SUMMARY v

LIST OF TABLES. ix

Section

I. INTRODUCTION. 1

II. INDEXES OF TRANSPORT OUTPUT 2

Output Data. 2

Weights. 5

The Indexes. 7

III. INDEXES OF OUTPUT FOR TRANSPORT AND COMMUNICATIONS. . . 12

IV. SOME IMPLICATIONS 17

Intertemporal Comparisons of Growth Rates. 17

USSR and U.S. Growth Rates 23

Comparisons of Output, Capital, and Employment 25

Appendix. DATA, SOURCES, AND METHODS 37

LIST OF PUBLICATIONS CITED. 59

LIST OF TABLES

Text Tables — Page

1. Indexes of Transportation Output, Including Common-Carrier Motor, 1928-1962 8
2. Alternative Indexes of Transportation Output, 1928-1962 9
3. Indexes of Transport and Communications Output, 1928-1962 16
4. Average Annual Rates of Increase of Output, USSR Transport and Communications 20
5. Average Annual Rates of Increase of Output, U.S. Transport and Communications 26
6. Output, Capital, and Employment in Transport and Communications, USSR, 1928-1962 29
7. Output, Capital, and Employment in Transport and Communications, United States, 1869-1953 31
8. Changes in Incremental Capital-Output Ratios, USSR, Transport and Communications 34

Appendix Tables

A-1 Output Series in Physical Units, Transport, 1928-1962.. 38
A-2 Aggregate Costs of Transport, by Carrier 43
A-3 Communications Employment and Output, 1928-1962 46
A-4 Indexes of Transportation Output, Including Common-Carrier Motor, 1928-1962 50
A-5 Indexes of Transport Output with Alternative 1955 Cost Weights, 1928-1962 52
A-6 Indexes of Freight Output, Alternatively Weighted by Operating Costs of Different Years 54
A-7 Indexes of Transport and Communications Output, 1928-1962 55

I. INTRODUCTION

Explorations and analyses of Soviet economic growth frequently suggest the usefulness of a separate consideration of the major sectors of the economy. An important impediment to such studies is the absence of an index of the output of Soviet transport and communications. Neither the official measures of output nor the numerous non-Soviet attempts to estimate output growth contribute an index of output for Soviet transport separately or for Soviet transport and communications combined. For example, the most recent U.S. study of the rate of increase of Soviet national product, [1],* constructs an index of national product from separate indexes of sector output and uses ton-kilometers of freight hauled by railroads as a surrogate for the output of all transport and communications.

The primary purpose of this Memorandum is to present the results of an attempt to construct output indexes for transport and communications. Section II concerns the output indexes for transport, and Section III the consequences of adding communications to transport.

With the indexes in hand, the pursuit of certain elementary implications of the results is irresistible. Section IV is devoted to these implications: an intertemporal comparison of rates of increase of Soviet output; a comparison of rates of increase of output in the Soviet Union and the United States; and a comparison of output increases with capital and labor increases.

Appended to this Memorandum is a set of tables, Appendix Tables A-1 to A-7, and notes to those tables. The data underlying the indexes and the sources and methods used will be found in the Appendix.

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*Numbers in brackets refer to the List of Publications Cited, p. 59.

II. INDEXES OF TRANSPORT OUTPUT

It should be clear at the outset that no intensive study of Soviet transportation underlies this Memorandum. I seek only to combine the readily available individual output series into an index of transport output by the use of cost weights which are also more or less readily available. The results, therefore, should be interpreted as aggregative implications of official output and cost data supplemented here and there by estimates necessary to fill in gaps.

I have benefited greatly from the discussion of Soviet freight transportation in [2]. That study has been used as a guide through the complexities of available data and as a source for comments on the scope of the output data. The reader might wish, in addition, to use that study to provide appropriate reservations to the results compiled here--especially reservations that stem from questions of the reliability of the output data.

OUTPUT DATA

The individual output components of the transport indexes are ton-kilometers of freight traffic and man-kilometers of passenger traffic for each of the major transport systems: railroad, maritime, internal waterway, pipeline, motor, and air. These data are in Table A-1 and require several comments with respect to scope.* Railroad ton-kilometers exclude company material hauled in non-revenue trains. Maritime ton-kilometers represent total maritime traffic, domestic as well as foreign trade traffic, carried in Soviet ships. Freight traffic on internal waterways represents powered traffic on rivers, canals, and other inland waterways; traffic on the Central Asian steamship lines is included in inland waterways ([3, pp. 379, 400]). Pipeline traffic is oil traffic.

In the case of motor freight traffic, two series are available and are included in Table A-1: for total motor transport and for motor transport of "general use" (obshchego pol'zovaniia). The

*Unless otherwise indicated, the comments on scope are based on [2, Chapter 1, pp. 33-39, Appendixes B and C].

distinction between motor transport of "general" use and "non-general" use appears to be analogous to the distinction between contract and force-account construction. Motor transport of general use refers to services rendered by independent transport organizations for payment by the user of such services; total motor transport also includes services rendered by administrative organizations, enterprises, and collective farms, apparently for their own respective uses.* In terms of ton-kilometers, motor transport of general use accounted for 5 per cent or less of total motor transport through 1952; thereafter, the percentage rose rapidly from 8 per cent in 1953 to 22 per cent in 1955, and 28 per cent in 1960-1962 (Table A-1).

Which of these series, if any, should be used in the transport index? Both freight and passenger traffic data for transport systems other than motor transport are described as referring to transport of "general use."** For reasons of comparability with other transport systems, therefore, it would seem advisable to include only motor transport of "general use." In [2, pp. 10-11], it is argued that, for purposes of comparability with U.S. freight data, all motor transport be excluded. Using data for total motor freight transport, [2] observes that motor transport appears to be short-haul, intracity, and feeder operations of the kind that is excluded from U.S. freight statistics. Motor freight transport of "general use" is somewhat longer haul but still appears to be predominantly intracity and feeder traffic.*** Nevertheless, motor freight transport appears to be developing rapidly in the USSR and, for purposes of assessing future developments, at least motor transport of "general use" should be included.

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*[3, pp. 379, 408, 681].

**For example, see [3, pp. 379, 381].

***The average length of haul in motor freight transport is stated in [3, pp. 405, 408] to be (in kilometers):

	1952	1958	1960	1962
Total motor transport	10.4	11.9	11.6	12.3
Motor transport of general use	19.5	16.1	15.9	16.6

I propose to compile the transport indexes in both ways: exclusive of all motor transport and inclusive of motor transport of "general use"--or, perhaps, to improve the terminology, "common-carrier" motor transport. Indeed, Table A-5 includes a third variant just to record the difference it makes, if any: that is, freight output including total motor transport.

To my knowledge, there is little additional information about the scope of the passenger traffic data except with respect to motor transport. As indicated above, all components of passenger traffic are described as passenger traffic of "general use"--that is, common-carrier transport. Except for motor transport, of course, the amounts of passenger transport of "non-general use" must be negligible. Motor passenger transport consists exclusively of motor bus transport of "general use," most of which, in terms of passenger-kilometers, is intracity transport; excluded from motor and total passenger traffic are taxi, trolley-bus, and subway traffic.*

Not all the output data used are stated as such in Soviet sources. For some years I could find no data for one or another of the output components in the sources consulted. Although I have engaged in no extensive search for data, I did examine the series of statistical handbooks published since 1955 as well as some of the handbooks published in the 1930s and, in the case of freight transport, the study ([2]) cited above. Where gaps prevailed, I filled them with various interpolations or estimates as indicated in the notes to Table A-1; in those cases where a sizable error seems possible the figure in Table A-1 is enclosed in parentheses. Where the handbooks presented contradictory figures for a particular year, the most recently published figure was accepted unless some reason to the contrary appeared.

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*See [3, pp. 381, 411, 414, 417, 421]. The ratio of intracity to total passenger-kilometers for motor-bus transport is:

1952	1958	1960	1962
.76	.71	.71	.72

WEIGHTS

The weights used to combine the output series into indexes of transport output are 1955 ruble costs per ton-kilometer or per passenger-kilometer for the relevant carrier. This selection of weights involved essentially two choices: the choice among several categories of cost and, for one category, the choice among weight-years within the 1952-1962 period.

From [4], data are available on 1955 transportation costs for freight and passenger traffic separately by each carrier except air. Costs of varying scope are stated or implied: operating costs; supplementary costs, which are primarily freight loading and unloading costs and outlays on the maintenance of routes and fixed installations; costs including and excluding turnover taxes on fuel; costs including and excluding freight loading and unloading. These data for the major cost categories are in Table A-2, columns (1)-(6) and (8)-(11). Analogous cost data for air transport, in columns (7) and (12) are rough estimates that start from cost figures reported orally by Soviet airline officials and proceed by more or less conjectural adjustments.

The data in Table A-2 are <u>not</u> costs per ton- or passenger-kilometer but are aggregate costs for the ton- or passenger-kilometers hauled by each carrier in 1955. When multiplied by the output series in Table A-1 restated as relatives with 1955 = 1.00, the cost data yield indexes of output with costs per ton- and passenger-kilometer as implicit weights.*

*Let $X_i^{(t)}$ represent the output of a particular carrier i in ton- or passenger-kilometers in year t and $C_i^{(0)}$ the cost per ton- or passenger-kilometer of that carrier in the base year 0. The indexes computed, $I^{(t)}$ for year t with year 0 as the base year equal to 100, are of the following form:

$$I^{(t)} = \frac{100 \cdot \sum_i \frac{X_i^{(t)}}{X_i^{(0)}} C_i^{(0)} X_i^{(0)}}{\sum_i C_i^{(0)} X_i^{(0)}}$$

There seems to be no obvious grounds for choice among the various cost categories for a preferred set of weights. Fortunately, we need not search far, for the results are relatively insensitive to that choice of weights. I proceed with the use of operating costs, including fuel turnover taxes, as weights on the heuristic grounds that the 1955 costs (item A in Table A-2) (a) tend to yield intermediate values within the narrow range of indexes for all transport including common-carrier motor, and (b) permit assessment of the effect of alternate weight years.*

With the use of operating costs as weights, one can try alternative weight years within the 1950-1962 period for at least freight transport. The weight year 1955 is preferable on several grounds. In 1955, a general wholesale price reform occurred. The valuations underlying the official capital and investment data, the recent links of official output indexes, and the indexes underlying several recent studies of Soviet output are 1955 prices. Most importantly, at least the readily available transport cost data cover more branches of transport for 1955 than for other years in the indicated period. Nevertheless, I have experimented with the alternative use of 1950 and 1960 operating costs as weights just to see whether the results are sensitive to the choice of the weight year. Table A-6 and the second footnote on p. 7 indicate that for freight transport the indexes differ somewhat, but not very much, when the weights are altered from 1955 to 1950 or 1960 costs. Both 1950 and 1960 costs yield larger increases in output than 1955 costs, and the largest increases occur with 1960 costs.

The data in Table A-2 represent $C_i^{(0)} X_i^{(0)}$ and the data in Table A-1 can be transformed into the relatives, $\frac{X_i^{(t)}}{X_i^{(0)}}$.

*The indexes that result from the alternative use of different cost categories are found in Table A-5. The data on operating costs for 1950 and 1960 are in Table A-2, item A.

THE INDEXES

The use of 1955 operating costs as weights to combine the ton- and passenger-kilometers of traffic by carriers yields the indexes of transport output summarized in Table 1 for selected years.* These indexes include only common-carrier motor transport as the motor component and refer separately to all freight transport, all passenger transport, and railroad freight and passenger transport. Each of these indexes is, of course, a component of the index for all transport output in column (4) of Table 1.

With the data at hand, it is possible to construct several alternative measures of all transport output. In order to compare the results of such alternatives with the measure in Table 1, the alternative measures are summarized in Table 2. Columns (1) and (2) present the indexes resulting from alternative weights--that is to say, from the use as weights of cost data of differing scope; columns (3)-(5) present the indexes resulting from the exclusion of motor transport and the use of alternative weights.** The exclusion of motor transport

*Annual indexes for 1928-1940 and 1945-1962 are in Table A-4.

**The effects of substituting still other cost categories as weights are in Table A-5. The results differ only trivially from the results in Tables 1 and 2.

The effect on the index of freight output of including total rather than common-carrier motor freight transport is also indicated in Table A-5. With operating costs as weights, the index for all freight with total motor transport is (1955 = 100): 1928 = 6.0, 1940 = 32.6, 1950 = 55.3, 1962 = 217.2. In comparison with the index in Table 1, column (1), the substitution of total for common-carrier motor freight yields an appreciably larger increase in freight output. The available data do not permit such a substitution in the cases of passenger transport and, hence, of all transport.

Finally, the consequences for the freight output index (including common-carrier motor) of a shift in the weight year are in Table A-6 and can be summarized as follows:

	Indexes of Freight Output (1955 = 100)		
	Operating Costs 1955	Operating Costs 1950	Operating Costs 1960
1928	9.3	9.1	8.9
1940	37.8	37.4	36.2
1950	56.3	55.8	53.8
1960	173.6	175.0	179.3
1962	197.5	199.1	203.4

Table 1

INDEXES OF TRANSPORTATION OUTPUT, INCLUDING COMMON-CARRIER MOTOR, 1928-1962

(1955 = 100)

Year	All Freight	All Passenger	Railroad Freight and Passenger	All Transport
	(1)	(2)	(3)	(4)
1928	9.3	14.9	11.2	10.6
1932	16.8	49.0	26.3	24.0
1937	33.5	52.8	42.4	37.8
1940	37.8	58.1	48.4	42.3
1945	29.4	38.8	35.4	31.4
1950	56.3	56.3	62.0	56.3
1953	76.0	79.0	82.5	76.7
1955	100.0	100.0	100.0	100.0
1958	142.7	133.7	129.4	140.7
1960	173.6	169.1	147.6	172.6
1962	197.5	217.1	162.0	201.8

Source:
Table A-4.

Table 2

ALTERNATIVE INDEXES OF TRANSPORTATION OUTPUT, 1928-1962
(1955 = 100)

Year	All Transport, Including Common-Carrier Motor		All Transport Except Motor		
	Weights: operating costs less fuel turnover taxes	Weights: operating and supplementary costs	Weights: operating costs	Weights: operating costs less fuel turnover taxes	Weights: operating and supplementary costs
	(1)	(2)	(3)	(4)	(5)
1928	10.6	10.4	11.9	11.9	11.8
1932	24.1	22.5	26.8	26.8	25.5
1937	38.0	36.6	42.0	42.0	41.2
1940	42.5	40.9	46.8	46.8	45.9
1950	56.3	55.8	61.6	61.3	61.8
1953	77.0	76.0	82.1	82.1	82.2
1955	100.0	100.0	100.0	100.0	100.0
1958	140.2	141.9	133.2	133.1	133.7
1960	171.7	174.3	157.4	157.3	157.6
1962	200.6	203.1	182.3	182.1	181.9

Source;
Table A-5.

yields indexes that increase appreciably more slowly than the indexes including motor transport. On the other hand, the alternative weights make essentially no difference in the transport output indexes whether inclusive or exclusive of motor transport.

What reservations need be attached to these results? The indexes are obviously makeshift with respect to both the output series and the weights employed. Even if the data on ton- and passenger-kilometers were perfectly reliable measures of what they purport to measure,* they are not quite what we would like to measure. Other aspects of output such as speed, reliability, and comfort are also relevant. Moreover, the aggregation of output for a given carrier in terms of ton- or passenger-kilometers is inadequate: the real resource costs of moving one ton or one passenger one kilometer must vary with such factors as the commodity hauled, the accommodations provided, and the length of haul.

In the determination of weights, the usual choice is that between gross-value and value-added weights. The use of costs as weights makes sense only if relative costs per unit of output bear some relationship to relative prices or relative values added per unit of output and I have no evidence on the relationship in the present case. Furthermore, I have essentially no basis to judge the reliability of the cost data used. Joint costs and the problems of allocating costs to different outputs for a given carrier pervade the transport sector and in the sources used there are essentially no explanations of the origins of the data stated and little additional detail.

Thus, for want of data, the readily available data have been used--compromises in several respects--for both the output series and the weights. The resulting indexes are submitted as a first attempt to measure the change in Soviet transport output and as a measure

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*See [2, pp. 9, 10, 15, 33-39, and Appendix B] for comments on the reliability of the ton-kilometer data. Some comments point only to the existence of doubts about reliability, but several point to a direction of bias--in the case of railroads, to an overstatement of weight and, hence, of ton-kilometers.

that is surely preferable to the selection of a surrogate such as railroad ton-kilometers to stand for the entire output.* Indeed, similar solutions to the problems of measuring U.S. transport output can be observed. In [5, Appendix G] and [6, Appendix I], ton- and passenger-miles by carriers are also used as the relevant individual output series, although the weights are revenues, not costs.**

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*See [1, p. 94]. The relationship between railroad ton-kilometers and the computed index is as follows (1955 = 100):

	Index of Transport Output	Railroad Ton-kilometers
1928	10.6	9.6
1940	42.3	42.7
1950	56.3	62.0
1960	172.6	154.9
1962	201.8	169.6

See Table 1, column (4), and Table A-1, column (1).

**In at least two respects, revenue and cost weights encounter analogous problems. (1) Both U.S. and USSR revenues reflect rate schedules whose economic content is, to say the least, questionable. (2) Given the compromises accepted in the use of aggregated ton- or passenger-miles for a given carrier, average revenue per ton- or passenger-mile will distort the results when the "product mix" in aggregate ton- or passenger-miles for a given carrier changes over time.

III. INDEXES OF OUTPUT FOR TRANSPORT AND COMMUNICATIONS

If one wishes to make comparisons by sectors of the economy between output and capital and to include transport in such comparisons, it is necessary to add communications output to transport output. Both the Soviet capital indexes and investment series combine transport with communications. In order to make such comparisons possible, therefore, an attempt will be made to obtain an output index for transport and communications combined despite the paucity of communications data. It is fortunate that all the alternative available measures of the relative importance of transport and communications testify to the predominance of transport in the total, so that relatively large errors in the index of communications output yield only small errors in the combined output index.

The communications sector includes the postal system, the telephone and telegraph system, and wireless broadcasting.* As one of the services sectors with diverse outputs, some paid for and some not, it is a sector for which the construction of an output index would be very difficult even with abundant data. The problem is complicated further in the Soviet case by the sparseness of published data. One expedient frequently seized on in dealing with service sectors is the use of employment as a surrogate for output measures and, thereby, the assumption of constant labor productivity.

The employment series for Soviet communications is presented in column (1) of Table A-3. Table A-3 also presents three kinds of additional data: (1) crude measures of the extent of particular communications systems--for example, kilometers of postal routes; (2) crude measures of individual outputs--for example, intercity telephone calls; and (3) a ruble measure of the output of communications.**

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*See [3, pp. 422-425].

**The measures of the extent of particular systems are in columns (4)-(6), the individual output measures in columns (6)-(11), and the ruble measure in column (12).

The employment data are available annually but take no account of changes in hours of work. The other data are available only for selected years, and in the case of the ruble output measure only for 1940, 1952, and 1958 and annually thereafter. No explanatory remarks with respect to scope or valuation are attached to the ruble measure.

Putting the ruble measure aside for a moment, does the employment series behave in at least rough consistency with the other measures of output and capacity? Transforming each of the series into relatives with 1952--or, alternatively, 1955--equal to unity, a rough consistency is observed.* For prewar years, the relatives for employment are within the range of the relatives for the other series. For the postwar years, however, even this rough consistency disappears unless the output index is assumed to be dominated by the postal system: the employment relatives are close to the relatives for the postal system in the postwar years but show increases substantially below those indicated by the non-postal relatives. On the other hand, the ruble measure of communications output increases more rapidly than the employment series in all periods represented. Link relatives for employment and ruble output are:

	Employment	Ruble Output
1952 (1940 = 1.000)	1.182	1.457
1958 (1952 = 1.000)	1.175	1.430
1962 (1958 = 1.000)	1.253	1.332

Given the available data, it seems that there are two major alternatives in the construction of an annual output index for communications. The first is to use the employment series as it stands and, thus, to ignore (a) the ruble measure because its nature is unexplained, and (b) the other output indicators because they are scattered and less than comprehensive. The second is to combine the employment series and the ruble measure by: (a) using the employment series as an interpolating index to obtain postwar ruble data for missing years, and (b) splicing an annual 1928-1940 index formed from the employment

*See note a to Table A-3.

series to an index for 1940 and 1945-1962 formed from the ruble data including the interpolations. The results of the two procedures are quite different.* For selected years with 1955 = 100, the two output indexes are:

Year	Employment	Combined Employment and Ruble Output
1928	15.5	11.4
1940	78.2	57.5
1950	88.7	75.3
1958	108.7	119.9
1962	136.2	159.8

In one respect the impact of the two indexes for communications is the same. Both show smaller rates of increase than the transport index, and either, when combined with the transport index, yields an index for transport and communications with smaller rates of increase than those implied by the transport index. Despite the differences between the two communications output indexes, the combined transport and communications output index is not very sensitive to the choice between the communications output indexes because of the dominance of the combined index by transport.

Alternatively measured in terms of 1955 employment, the 1955 stock of capital, and 1955 ruble output, the relative importance of communications in communications and transport is as follows:**

Employment	10.8 per cent
Capital	5.2 per cent
Output	8.9 per cent.

These measures of relative importance are used as alternative weights to combine the transport and communications output indexes. The employment and capital measures are used as limits of a range resembling value-added weights to combine the communications employment series with the transport index in column (4) of Table 1. If the communications ruble output data are regarded as reliable measures for the

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*See Table A-3, column (12), and note b for the interpolated ruble values and the method of interpolation; Table A-7, columns (2) and (3), for the annual data resulting from the two procedures; and note a to Table A-7 for the method of combining the employment and ruble output data.

**For data sources and methods of calculation, see note b to Table A-7.

years represented and, hence, the communications output index is that obtained by combining the employment and ruble output data, then the 1955 output percentages may be used as weights to combine the same transport index and the communications index obtained from employment and output data. The results are in Table 3 for selected years with 1955 = 100.*

For transport and communications combined, the output indexes differ, but not by much. Variants II and III are very close, differing by 0.5 percentage points or less. Variants I and III differ by at most 3 percentage points and in many years by 1 percentage point or less. Section IV will rely primarily on Variant III of the transport and communications output index with occasional side glances at Variant I to make sure that conclusions are not sensitive to the choice between them.

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*Annual data are in Table A-7.

Table 3

INDEXES OF TRANSPORT AND COMMUNICATIONS OUTPUT, 1928-1962

(1955 = 100)

Year	All Transport	Communications		Transport and Communications		
		Employment Series	Combined Employment & Ruble Output	Variant I	Variant II	Variant III
	(1)	(2)	(3)	(4)	(5)	(6)
1928	10.6	15.5	11.4	11.1	10.9	10.7
1932	24.0	36.7	27.0	25.4	24.7	24.3
1937	37.8	61.4	45.2	40.3	39.0	38.5
1940	42.3	78.2	57.5	46.2	44.2	43.7
1945	31.4	69.7	50.2	35.5	33.4	33.1
1950	56.3	88.7	75.3	59.8	58.0	58.0
1953	76.7	95.3	89.2	78.7	77.7	77.8
1955	100.0	100.0	100.0	100.0	100.0	100.0
1958	140.7	108.7	119.9	137.2	139.0	138.8
1960	172.6	120.8	138.8	167.0	169.9	169.6
1962	201.8	136.2	159.8	194.7	198.4	198.1

Source:

Table A-7. As in that Table, column (4) combines columns (1) and (2) with weights of .892 and .108, respectively. Column (5) combines columns (1) and (2) with weights of .948 and .052, respectively. Column (6) combines columns (1) and (3) with weights of .911 and .089, respectively.

IV. SOME IMPLICATIONS

Given the indexes computed here, at least three questions arise immediately. Is there any evidence of a deceleration in the growth rates for transport and communications? How do the Soviet growth rates compare with U.S. rates? How do the output increases compare with time changes in capital and employment?

INTERTEMPORAL COMPARISONS OF GROWTH RATES

Several students of the Soviet economy have noted the appearance of a sizable decrease in the rate of increase of output for the post-1958 period; the observation is held to apply not only to agriculture but to industry and to gross national product as well.* The question

*For example, see [1, pp. 91-98] with the following results in terms of percentage rates of increase:

	Gross National Product	Nonagricultural Gross National Product
1950-1955	6.6	8.1
1955-1958	8.2	8.2
1959	3.9	8.3
1960	5.0	6.2
1961	6.5	5.7
1962	2.2	5.7
1958-1962	4.4	6.5

The rates of increase for periods greater than one year are the average annual rates of increase implied by the initial- and terminal-year values. The method used in this study is to combine separate sector output indexes by means of 1955 weights intended to represent income originating in each of the sectors. The results for nonagricultural gross national product are not stated as such in [1]; using the data in [1], those results are obtained simply by excluding agriculture.

This is the study referred to above, in the first footnote on p. 11, in which railroad ton-kilometers are used to represent all transport output. Communications output is measured by the ruble output series in column (12) of Table A-3, but with unspecified interpolations for 1950 and 1955. I have substituted the transport and communications output index calculated here for the transport and communications output measures used in [1] and combined them with the other output indexes in [1] by means of the weights in [1]. Only slight differences result. The percentage rates of increase are:

is whether a similar deceleration holds for transport and communications output. With respect to comparisons over longer periods of time, a related question is whether the rates of increase from 1950 on exceed or are exceeded by the prewar rates.

The annual percentage increases in transport and communications output for 1928-1940 and 1945-1962 are plotted in Fig. 1. For purposes of further discussion, the 1940-1945 period of substantial war damage and the early postwar recovery period are omitted. It is clear from the figure that the prewar period shows considerably greater instability in growth rates than the period from, say, 1950 on. After very rapid growth in 1928-1932, the index shows less rapid growth in 1932-1937 (including one year when output decreased), and little growth in 1937-1940 despite the 1939-1940 territorial acquisitions for which no adjustment is made. In the post-1950 period, the growth rate varies from 8 to 13 per cent, except for an increase of almost 16 per cent in 1955. Nevertheless, the figure indicates lower postwar growth rates after 1958 than before.

To summarize the performance of the transport and communications sector and of major components thereof in terms of growth rates, Table 4 presents average annual rates of increase for various prewar periods and various postwar periods from 1950 on. The rates under A present the conventional measure of the average annual rate of increase --the rate that yields the terminal-year value from the initial-year value when compounded annually in a specified period. The conventional measure ignores output flows within the specified period, and,

	Gross National Product	Nonagricultural Gross National Product
1950-1955	6.6	8.1
1955-1958	8.2	8.3
1959	4.0	8.5
1960	5.2	6.5
1961	6.6	5.9
1962	2.4	6.0
1958-1962	4.6	6.7

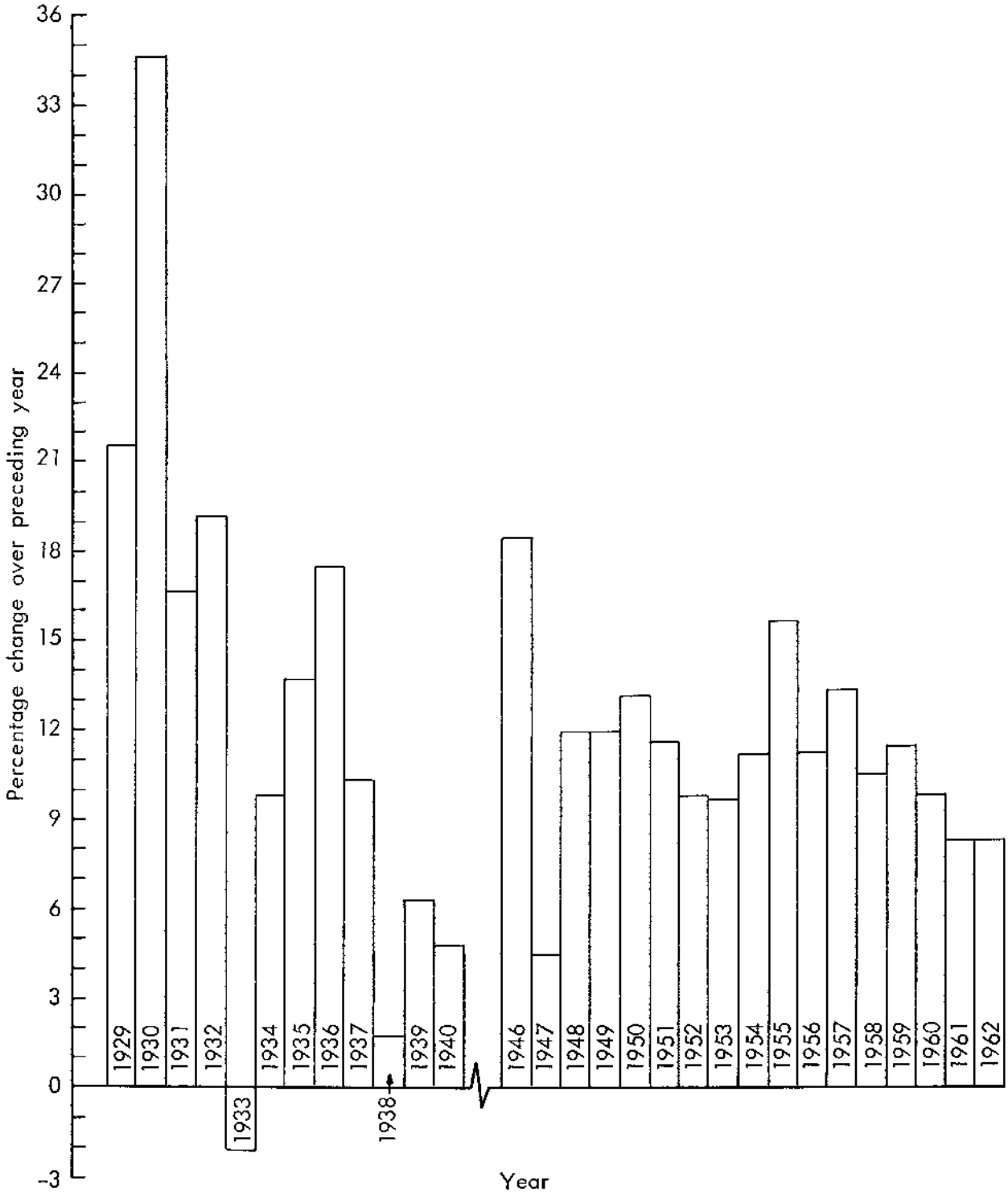

Fig. 1—Annual percentage change in transport and communications output

Source: Table A-7, column (6)

Table 4

AVERAGE ANNUAL RATES OF INCREASE OF OUTPUT, USSR TRANSPORT AND COMMUNICATIONS
(per cent)

	1928-1937	1928-1940	1932-1937	1932-1940	1950-1958	1958-1962	1950-1962	1953-1958	1953-1962
A. Rates implied by initial and terminal years									
Transport and communications	15.3	12.5	9.6	7.6	11.5	9.3	10.8	12.4	10.9
Transport	15.2	12.2	9.5	7.3	12.1	9.4	11.2	12.9	11.3
Railroad transport	15.9	13.0	10.0	7.9	9.6	5.8	8.3	9.4	7.8
B. Rates yielding total output									
Transport and communications	16.9	14.8	7.8	7.9	11.3	9.8	11.2	12.5	11.7
Transport	16.7	14.6	7.3	7.5	12.0	10.0	11.7	13.2	12.2
Railroad transport	17.4	15.3	7.5	7.9	9.9	6.3	9.2	9.7	8.7

Source:
Table A-4, column (3); Table A-7, columns (1) and (6). The methods of calculation are explained in the footnote on page 21.

when annual growth rates vary, is likely to provide somewhat misleading results. The rates under B, accordingly, present an alternative measure of the average annual rate of increase--the rate that yields the sum of the observed values from the initial-year value when compounded annually in a specified period.* As a consequence of the variation in annual growth rates, the two methods yield different results. Let us concentrate on the results under B.

For transport and communications, transport, and railroad transport, output increases considerably less rapidly in 1958-1962 than in either 1950-1958 or 1953-1958. The deceleration noted for other segments of the economy and for the economy as a whole holds also for transport and communications, for transport, and for railroad transport.

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*Let X_1, X_2 ... X_N represent the values of the output index for years 1, 2...N. The average annual rate of increase implied by initial and terminal years is that value of α which satisfies the equation:

$$X_1(1 + \alpha)^{N-1} = X_N \qquad (1)$$

The average annual rate of increase yielding total output is that value of α which satisfies the equation:

$$X_1 + X_1(1 + \alpha) + X_1(1 + \alpha)^2 + \ldots + X_1(1 + \alpha)^{N-1} = \sum_{n=1}^{N} X_n \quad . \qquad (2)$$

I am led to a general preference for a measure which is influenced by all values in a given period by Boris Pesek's excellent essay [7, pp. 295-315]. The method I use is his method VI, which has the disadvantage of undue sensitivity to the initial-year value. His preferred method, method VII, is free from such sensitivity but requires an elaborate computational procedure.

Method VI, the solution of equation (2), is applied as follows. Equation (2) reduces to:

$$\frac{(1 + \alpha)^N - 1}{\alpha} = \frac{\sum_{n=1}^{N} X_n}{X_1} \qquad (3)$$

Although there is no general solution to (3) for α, the required α can be obtained by numerical methods from tables that express the amount of annuity of 1 per period at compound interest α in period N.

The same problem of appropriate measurement pervades the intertemporal and international comparisons of growth rates. With a

In a comparison of the post-1950 rates of increase with the prewar rates of increase, the rates for 1950-1962 or 1953-1962 are substantially less than those for 1928-1937 or 1928-1940. The earliest segment of the prewar period is crucial, however: the 1950-1962 and 1953-1962 rates of increase exceed those for 1932-1937 and 1932-1940; except for railroad transport, even the 1958-1962 rates of increase exceed those for 1932-1937 and 1932-1940.*

Thus, within the post-1950 period, the rates of increase of output for transport and communication tend to decrease. As between the 1928-1937 or 1928-1940 periods and the post-1950 period, the rates of increase of output also tend to decrease. If the 1932-1937 or 1932-1940 period is taken as the prewar base period, however, the tendency is for the postwar rates of increase to exceed the prewar rates.

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computational program generously provided by Professor Pesek, I have underway the application of his method VII to the determination of average annual rates of increase for the major Soviet output indexes and, for purposes of comparison, the corresponding U.S. output indexes. As yet I do not have results for transport and communications and I rely, therefore, on the use of the conventional measure and Pesek's method VI.

*The results under A in Table 4 yield the same general trends. The exceptions are: the 1958-1962 rates of increase, except for railroad transport, are about the same as those in 1932-1937; and the 1953-1962 rate of increase for railroad transport is about the same as that in 1932-1940.

It should also be noted that the use of Variant I of the transport and communications index in place of Variant III will not affect the intertemporal comparisons. The average annual rates of increase for Variant I, measured as under A are (in percentages):

1928-1937	15.4	1950-1958	10.9
1928-1940	12.6	1958-1962	9.1
1932-1937	9.7	1950-1962	10.4
1932-1940	7.8	1953-1958	11.8
		1953-1962	10.6

See Table A-7, column (4).

USSR AND U.S GROWTH RATES

To compare these output increases with those in the United States one must first obtain output data for a sector of even roughly comparable scope in the United States and the Soviet Union. In [5] and [6] output indexes are compiled for private transport, communications, and public utilities. Although the outputs of some segments are imputed rather than measured directly, the measures are intended to represent the output of the following segments of the economy: railroads, street and electric railways, local bus lines, other local transit, the telephone and telegraph systems, electric light and power, highway freight and passenger transport, pipelines, water transport, air transport, radio and television, manufactured and natural gas, water supply and irrigation.* For comparability with the Soviet data one should (a) exclude the major public utilities--electric power and gas--as well as water supply, irrigation, street and electric railways and other local transit (except local bus lines); and (b) add the output of the postal system.

The available data do not permit exclusion of water supply, irrigation, and other local transit. Because other local transit cannot be excluded, street and electric railways have been left in. Although postal output can be added from [5, pp. 303, 611], its addition would complicate comparisons between transport and communications output on the one hand, and capital and labor on the other, for post office capital is not separately available. Accordingly, I have used the data from [5] and [6] to construct output indexes for transport and communications by excluding the major public utilities, and I use the indexes stated in [5] and [6] for transport and railroad transport separately.

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*See [5, pp. 507, 513, 516, 519, 521, 524, 531, 532, 533-534, 558, 561, 565, 572, 575-576], and [6, pp. 4-6, 231, 244, 463, 471]. I am not aware of any major differences in scope between the measures in [5] and [6] and they frequently use the same sources of data. For major segments, indeed, the component indexes are the same or similar. The overall results nevertheless differ because of differences in component indexes, weights, and methods of imputation for segments whose output is not measured directly.

Table 5 presents the average annual rates of increase--calculated by the two methods indicated previously--implied by the Ulmer indexes from [6] and the Kendrick indexes from [5]. The average annual rates of increase for railroad transport are the same or virtually so whether from [5] or [6]* and, hence, are not repeated. Although the underlying data refer to only private transport and communications, the addition of output from government enterprises would undoubtedly make little difference. The major public utilities have been excluded from the index so that only the output of publicly owned local transport and water systems is relevant.**

Comparisons between Tables 4 and 5 yield the general conclusion that the rates of increase of output for Soviet transport and communications and its major components greatly exceed those in the United States.*** For transport and communications as a whole, the U.S. rates

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*See [5, pp. 543-545] and [6, pp. 472-473]. Small unexplained differences in the railroad output indexes appear in several of the years after 1940.

**See [6, pp. 488-489] for the relatively small amount of passenger traffic on municipally owned street and electric railways for 1917-1937.

***These conclusions remain unaltered if the U.S. output indexes are adjusted to exclude street and electric railways and/or to add post office output.

1. In the case of the Ulmer output data, I have subtracted the output of street and electric railways ([6, pp.486-487]) from the totals previously obtained for transport and communications and for transport separately. The resulting average annual rates of increase are (in percentages):

	1890-1900	1899-1909	1909-1919	1919-1929	1929-1950
A. Rates Implied by Initial and Terminal Years					
Transport and Communications	5.9	7.1	4.7	2.6	3.3
Transport	5.9	6.6	4.8	1.8	3.3
B. Rates Yielding Total Output					
Transport and Communications	4.6	7.9	5.3	2.2	2.3
Transport	4.8	7.4	5.3	1.4	2.4

2. In the case of the Kendrick output data, I have considered separately the effects of eliminating street and electric railways, of adding post office output, and of doing both. Post office output is from [5, pp. 303, 611] and street and electric railways from

in 1869-1889 and 1889-1909 approach the USSR rates in 1932-1937, 1932-1950, and 1958-1962; all other comparisons show larger rates of increase for the USSR. For transport, the same conclusions hold. For railroad transport, the U.S. rate of increase in 1880-1890 equals or exceeds the USSR rates in 1932-1937, 1932-1940, 1953-1962, and 1958-1962; and the U.S. rate in 1899-1909 exceeds the USSR rate in 1958-1962. Otherwise, again, the USSR rates are substantially larger.

COMPARISONS OF OUTPUT, CAPITAL, AND EMPLOYMENT

Given the computed index of transportation and communications output and readily available capital and employment series for the USSR, the question is whether output has increased more or less than

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[5, pp. 548-550]. The weights are obtained as follows: In 1929, national income originating in local railways, bus lines, and passenger highway transport is .825 billion dollars ([8, p. 176]). Using the 1929 ratio of persons engaged in local railways ([5, p. 556]) to total persons engaged in local railways, bus lines, and passenger highway transport ([8, p. 202]), I obtain an estimated .411 billion dollars for national income originating in local railways. Using the 1929 ratio of persons engaged in the post office to those in local railways ([5, pp. 556, 611]) and the previous income originating figure, I obtain an estimated .488 billion dollars for national income originating in the post office. The resulting average annual rates of increase are (in percentages):

	Transport and Communications			Transport
	Excluding Local Railways	Adding Post Office	Excluding Local Railways and Adding Post Office	Excluding Local Railways
1869-1879	-	7.1	-	-
1879-1889	-	9.6	-	-
1889-1899	5.9	6.0	5.9	5.7
1899-1909	4.9	4.6	4.4	4.4
1909-1919	4.1	4.1	4.2	3.9
1919-1929	2.9	2.8	3.0	1.9
1929-1937	0.6	0.2	0.5	0.7
1937-1948	6.9	6.7	6.8	7.0
1948-1953	1.4	1.3	1.5	1.7

Table 5

AVERAGE ANNUAL RATES OF INCREASE OF OUTPUT, U.S. TRANSPORT AND COMMUNICATIONS
(per cent)

Rates	1869-1879	1879-1889	1880-1890	1889-1890	1890-1900	1899-1909	1909-1919	1919-1929	1929-1937	1937-1948	1937-1950	1948-1953
A. Rates implied by initial and terminal years												
Ulmer												
Transport and communications	-	-	-	6.1	6.0	7.2	4.7	2.3	Decr.	6.7	5.6	-
Transport	-	-	-	-	6.0	6.8	4.7	1.6	Decr.	6.5	4.7	-
Railroad transport	-	-	8.5	5.6	5.5	6.9	4.4	0.8	Decr.	5.3	3.6	-
Kendrick												
Transport and communications	7.0	9.7	-	6.0	-	5.1	4.1	2.7	0.3	6.8	-	1.2
Transport	7.0	8.5	-	5.9	-	4.6	3.9	2.0	0.4	6.8	-	1.6
B. Rates yielding total output												
Ulmer												
Transport and communications	-	-	-	5.4	4.8	8.1	5.2	2.0	Decr. 2.0	8.0	7.2	-
Transport	-	-	-	-	4.8	7.6	5.2	1.3	Decr. 2.0	8.2	7.3	-
Railroad transport	-	-	8.5	4.9	4.2	6.9	4.9	0.4	Decr. 0.5	7.8	6.5	-

Notes and Sources:

- Indicates insufficient data for calculation.

Decr. Indicates that output has decreased.

a. The average annual rates of increase are calculated as indicated in the footnote on p. 21.

b. The Ulmer output data are from [6. pp. 458-459, 464-465, 472-473]. The data are in 1929 dollars. To obtain transport and communications output, I have subtracted from Ulmer's total for all regulated industries his data for (a) electric light and power, and (b) manufactured and natural gas.

(continued)

Notes and Sources to Table 5 (continued):

c. The Kendrick output data are from [5, pp. 302-303, 540, 543-545, 580, 590-593] and, for the 1889 index for electric power, from [6, pp. 464-465]. The relevant output indexes are those for transport, railroad transport, communications and public utilities, electric power, and manufactured and natural gas. To obtain transport and communications output, I have excluded electric power and gas from communications and public utilities and combined the resulting index with that for transport. The relevant weights are 1929 national income originating in each sector as follows (in billion dollars):

Transport	6.636
Communications and public utilities	2.864
Electric power	1.091
Manufactured and natural gas	0.540

The weights are from [5, p. 557] and [8, p. 176] except for the apportionment of 1929 national income for electric and gas utilities between the two. This apportionment is in proportions representing persons engaged in each segment from [5, p. 598].

For 1869 and 1879, Kendrick states no index for manufactured and natural gas. The transport and communications index for 1869 and 1879 is obtained from the 1889 value by using, as a backward extrapolating index, transport and communications excluding only electric power. The method of extrapolation is that described in [9, pp. 61-68], with the 1889-1899 period as the base period.

The weights employed here to obtain the Kendrick output index for transport and communications are not quite the same as those used by Kendrick. For at least some periods and some components, Kendrick uses a system of weights that differ by subperiods in accordance with the Marshall-Edgeworth index formula. (See [5, pp. 287, 534, 578].) Unfortunately -- and this is a frequent blemish in [5] -- Kendrick does not present sufficient information to make it possible to duplicate his procedures or to apply his methods to measures of different scope. Accordingly, I have used fixed 1929 weights in recombining his component output indexes. What differences result between my procedure and the consistent application of his is unclear. A table that purports to show the differences between changing and fixed weights for the private domestic economy as a whole -- and the differences are not substantial -- turns out on closer examination to express the difference between (a) gross private domestic product in 1929 dollars, and (b) an aggregation of sector output indexes with variable weights. See [5, Tables A-XVIII and A-III, pp. 298-301, 327].

the increase in capital and employment. Table 6, rows (1)-(3), presents the basic series for output, capital, and employment in selected years. The years chosen are those for which all series exist. The capital values are the official values, gross of depreciation or wear and tear at July 1, 1955 prices, and are obtained from the January 1, 1960 capital values and indexes of changes in the volume of capital. The employment series takes no account of time changes in average hours of work.

Table 6, rows (4)-(6) and (7)-(9), expresses the basic series as indexes with 1928 equal to 100 and as link relatives for major sub-periods with the initial year of each sub-period equal to 100. The results are clear. Over the 1928-1962 period as a whole, output has increased by much more than the increase in either capital or employment taken separately and, therefore, by much more than the increase in factor inputs combined regardless of the weights used to combine them. Moreover, for each of the sub-periods taken separately the same inequality holds: an output increase in excess of input increases.*

The persistence of that inequality might lead some to question the reliability of the output or capital series. Although I am unaware of any sources of error sufficiently potent and in the right direction to remove the divergence between the output and capital increases, I am not prepared at the moment to go any further in assessing the reliability of the series. It is interesting to observe, however, that U.S. data for 1869-1950 reveal the same inequality.

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*Table 6 presents these results for the 1959-1962 period as a whole. Within that period, the annual comparisons of link relatives are:

	1959-1960	1960-1961	1961-1962
Output	109.8	108.1	108.1
Capital	109.4	107.9	107.4
Employment	105.3	104.1	102.8

It should be observed, also, that the same results hold for all sub-periods if Variant I of the transport and communications output index is substituted for Variant III in Table 6, row (1). See Table A-7, column (4).

Table 6

OUTPUT, CAPITAL, AND EMPLOYMENT IN TRANSPORT AND COMMUNICATIONS, USSR, 1928-1962

		1928	1940	1953	1959	1960	1961	1962
The basic series								
Output (1955 = 100)	(1)	10.7	43.7	77.8	154.5	169.6	183.3	198.1
Capital (billion 1955 rubles; Jan. 1)	(2)	43.8	154.4	237.2	354.1	387.4	417.9	448.9
Average annual employment (millions)	(3)	1.365	3.903	5.352	6.663	7.017	7.308	7.509
Indexes (1928 = 100)								
Output	(4)	100	408	727	1444	1585	1713	1851
Capital	(5)	100	353	542	808	884	954	1025
Employment	(6)	100	286	392	488	514	535	550

Link relatives by subperiods (initial year = 100)		1928-1940	1940-1953	1953-1959	1959-1962
Output	(7)	408.4	178.0	198.6	128.2
Capital	(8)	352.5	153.6	149.3	126.8
Employment	(9)	285.9	137.1	124.5	112.7

Sources:

Row (1): Table A-7, column (6).

Row (2): These are the official Soviet capital values, gross of depreciation or wear and tear at July 1, 1955 rubles. They are obtained from the January 1, 1960 capital value in [10, p. 67] and the capital indexes with 1928 = 100 in [3, p. 52] and [12, p. 68]. This process yields prewar capital values for January 1, 1941 and, apparently, average 1928. I have amended such values to refer to January 1, 1940 and January 1, 1928 by the use of the prewar average annual rate of increase of capital. If the dating of the 1928 index refers to January 1, 1929, the January 1, 1928 capital value becomes 41.4 billion rubles and the 1928-1940 link relative for capital (1928 = 100) becomes 373.

Row (3): [11, pp. 658-659] and [3, p. 453].

Rows (4)-(9): Calculated from rows (1)-(3).

Table 7, rows (1)-(5), presents the basic series for U.S. output, capital, and employment. The scope of transport and communications differs in Tables 5 and 7. In Table 7, of the two major public utilities--electric power and gas--only one is excluded. Because of the absence of separate capital values, gas could not be excluded here. Both the Ulmer and Kendrick output series are included. The output and capital series are in 1929 dollars and the capital values are net of depreciation. Two employment measures--persons engaged in full-time equivalents and man-hours--are used.

Table 7, rows (6)-(10) and (11)-(15), again expresses the basic series as indexes (here with 1929 equal to 100) and as link relatives for major sub-periods with the initial year of each sub-period equal to 100. The results are again clear, are essentially the same as those for the USSR, and are independent of which output series and which employment series are used. Over the period as a whole,* output has increased by much more than the increase in either capital or employment taken separately and, therefore, by much more than the increase in factor inputs combined. Moreover, for each of the sub-periods taken separately the same inequality holds: an output increase in excess of input increases.**

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*For the Ulmer output series, 1880-1950; for the Kendrick output series, 1869-1948 and by extrapolation of capital values, 1869-1953.

**Given the dates represented in Table 7, only the 1929-1937 and 1937-1948 sub-periods have been omitted and that is because of the abnormality of the 1929-1937 period and the probable atypicality of 1937 as an initial or terminal year. In any event, the results for these periods are:

	1929-1937	1937-1948
Output		
Ulmer	92.6	202.1
Kendrick	102.9	205.3
Capital	97.6	101.8
Employment		
Persons engaged	78.2	134.3
Man-hours	72.1	135.5

It should also be observed that the results differ as between the United States and the USSR in one respect. In the United States, capital-labor ratios increase for some sub-periods and decrease for others; over the 1869-1948 period as a whole, the ratio of capital to man-hours is unchanged and the ratio of capital to persons engaged has decreased substantially.

Table 7

OUTPUT, CAPITAL, AND EMPLOYMENT IN TRANSPORT AND COMMUNICATIONS, UNITED STATES, 1869-1953

		1869	1879	1880	1889	1899	1909	1919	1929	1937	1948	1950	1953
The basic series													
Output													
Ulmer (billion 1929 dollars)	(1)	-	-	.757	1.557	2.845	5.770	9.168	11.681	10.813	21.854	22.066	-
Kendrick (1929 = 100)	(2)	3.5	6.8	-	17.0	30.2	50.5	75.8	100.0	102.9	211.3	-	231.4
Capital (billion 1929 dollars; January 1)	(3)	7.361	11.384	11.573	15.847	19.838	26.130	31.966	35.872	35.027	35.664	38.128	-
Employment													
Persons engaged (millions)	(4)	.604	.816	-	1.520	2.048	2.991	3.848	3.774	2.953	3.964	-	4.014
Man-hours (billions)	(5)	1.951	2.648	-	5.090	6.726	9.540	10.331	9.690	6.982	9.471	-	8.937
Indexes (1929 = 100)													
Output													
Ulmer	(6)	-	-	6.5	13.3	24.4	49.4	78.5	100.0	92.6	187.1	188.9	-
Kendrick	(7)	3.5	6.8	-	17.0	30.2	50.5	75.8	100.0	102.9	211.3	-	231.4
Capital	(8)	20.5	31.7	32.3	44.2	55.3	72.8	89.1	100.0	97.6	99.4	106.3	-
Employment													
Persons engaged	(9)	16.0	21.6	-	40.3	54.3	79.3	102.0	100.0	78.2	105.0	-	106.4
Man-hours	(10)	20.1	27.3	-	52.5	69.4	98.5	106.6	100.0	72.1	97.7	-	92.2

Link relatives by sub-periods (initial year = 100)		1869-1879	1879-1889	1880-1889	1889-1899	1899-1909	1909-1919	1919-1929	1929-1948	1929-1950	1929-1953
Output											
Ulmer	(11)	-	-	205.7	182.7	202.8	158.9	127.4	187.1	188.9	-
Kendrick	(12)	194	250	-	178	167	150	132	211.3	-	231.4
Capital	(13)	154.7	139.2	136.9	125.2	131.7	122.3	112.2	99.4	106.3	-
Employment											
Persons engaged	(14)	135.1	186.3	-	134.7	146.0	128.7	98.1	105.0	-	106.4
Man-hours	(15)	135.7	192.2	-	132.1	141.8	108.3	93.8	97.7	-	92.2

Note: - Indicates no data available.

Sources:

Row (1): [6, pp. 458-459, 464-465]. The output measure refers to all regulated industries less electric power. The output measure here differs from that in Table 5 in that gas is not excluded here. The reason is that capital values for gas are not separately available.

Row (2): [5, pp. 303, 590-591] and, for the 1889 index for electric power, [6, pp. 464-465]. Here, again, only electric power is excluded from transport, communications, and public utilities. The weights involved are obtained as indicated in note c to Table 5 and are the same as stated there with appropriate correction for gas.

Row (3): [6, pp. 235-236, 320-321]. The reference of the capital values is to all regulated industries except electric power. The initial capital values in [6] are for January 1, 1870. I have obtained a figure for January 1, 1869, by assuming the same percentage increase between 1869 and 1870 as between 1870 and 1871.

Rows (4) and (5): [5, pp. 308, 314, 590-591, 598]. Electric power is subtracted from transport, communications, and public utilities. For 1889, the data for electric power are obtained as the same proportions of the 1899 figures as the 1899 figures are of the 1909 figures. By 1899, the electric power employment figures are already sufficiently small to indicate only trivial errors in the 1889 totals as a consequence of this arbitrary procedure. Capital and output data from [6] indicate zero employment in electric power in 1879 and 1869.

For the United States but not for the USSR, it is possible to make the same comparisons for major components of transport, communications, and public utilities separately: for transport, railroad transport, local street railways and bus lines, communications and public utilities, electric power, manufactured and natural gas,* natural gas, the telephone system, and the telegraph system. In all cases except natural gas and the post-1929 telegraph system, the same result persists: the output increases exceed the increases in capital and labor inputs.**

In recent years a similar observation for the economy as a whole has commanded the attention of many. Given the excess in the increase of national product over the increase of factor inputs, the problem is to explain that substantial part of the output increase unaccounted for by input increases. Is it technical change or something else? If it is technical change, is it independent of capital formation or somehow embodied in capital changes? The data at hand and the nature of the sectors to which they apply suggest that something else besides technical change may also be involved--namely, indivisibilities and economies of scale. How much of the observed residual between output and input increases is accounted for by the behavior of outputs and inputs in transportation, communications, and public utilities? How much of that behavior is explained by technical change or something else?

The substantial and steady decreases in capital-output ratios for transport and communications in the USSR and the United States also raise other issues. For the economy as a whole, the capital-output ratio in the USSR appears to be rising. In the United States it has been stable or rising over long periods of time, excluding the

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*In this case and that of natural gas alone [5, pp. 570, 592-597] presents indexes of capital but fails to present sufficient information to determine the capital values in dollars upon which the indexes are based.

**See [5, Appendixes G and H] and [6, pp. 235-236, 256-257, 320-321, 374-375, 405-406, 440, and Appendix I].

link between 1929 and the immediate postwar period. If these observations are all correct, then there must be either (a) some sector or sectors for which the capital-output ratio is increasing, or (b) substantial shifts in the relative importance of sectors. The implication would seem to be that studies involving capital-output ratios or the residual between output and input increases should not stop with averages for the economy as a whole. It seems that the separate behavior of specific sectors and the consequences of any changes in their relative importance should play a prominent role in such studies wherever possible.

For many purposes, of course, the incremental capital-output ratio is a more relevant relationship than the average capital-output ratio. Given the evidence of recent deceleration in the Soviet economy, it seems especially interesting to know the trends, if any, in incremental capital-output ratios.* For transport and communications, the changes in the incremental capital-output ratios, derived from the series in Table 6, are presented in Table 8, column (1). Because of the opportunity to add observations for railroad transport and, for different periods, for transport and communications I also present in Table 8, columns (2) and (3), the changes in the ratio of investment to output increments. The numerators, of course, differ between column (1) and columns (2) and (3); in column (1), the numerators are gross increments to capital -- gross of depreciation or wear and tear but net of capital retirements; in columns (2) and (3), the numerators are gross investment -- that is, without account for depreciation, wear and tear, or retirements, but net of capital repairs. In the upper part of Table 8 the incremental capital-output ratio for 1953-1959 is taken as 1.00 and the other entries indicate whether and by how much such ratios for other periods exceed or are exceeded by the 1953-1959 ratio; in the lower part the ratio for 1953-1956 is taken as 1.00.

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*One cannot ordinarily deduce trends in incremental capital-output ratios from trends in average capital-output ratios, or conversely, for the two are not related as average and marginal functions. See [13, pp. 207-209 and fn. 11].

Table 8

CHANGES IN INCREMENTAL CAPITAL-OUTPUT RATIOS, USSR, TRANSPORT AND COMMUNICATIONS

	Ratio of Capital Increment to Output Increment	Ratio of Investment to Output Increment	
		Transport and Communications	Railroad Transport
	(1)	(2)	(3)
1953-1959 Ratio = 1.00			
1928-1940	2.20	-	-
1940-1953	1.59	-	-
1951-1953	-	1.91	1.34
1953-1959	1.00	1.00	1.00
1959-1962	1.43	2.01	1.93
1953-1956 Ratio = 1.00			
1950-1953	-	1.57	1.35
1953-1956	-	1.00	1.00
1956-1958	-	1.07	.99
1958-1960	-	1.27	1.36
1960-1962	-	1.77	1.96

Notes and Sources:

- Indicates no data available.

a. The forms of the calculations are as follows. For a given period with initial and terminal years 0 and t, let K_t = capital at the beginning of year t, and Y_t and I_t = output and investment in t. The ratio of the capital increment to the output increment is:

$$\frac{K_t - K_0}{Y_t - Y_0} \quad .$$

The ratio of investment to the output increment is:

$$\frac{\sum_{t=0}^{t-1} I_t}{Y_t - Y_0} \quad .$$

The output data used are in index form with 1955 = 100. If Y_{55} = output in 1955, each denominator is:

$$\frac{Y_t - Y_0}{Y_{55}} \cdot 100 \quad .$$

When the change in the ratios is calculated, the $100 \div Y_{55}$ cancels.

b. The capital data are from Table 6, row (2). The output data are from Table A-4, column (3), and Table A-7, column (6).

c. The investment data are from [3, p. 434] and [15, pp. 66-68] except for the 1951 figures which are obtained from the 1950 and 1952 sector distributions of nonagricultural socialized investment by using the average of the two relative distributions.

Both measures in Table 8 reveal the same picture: an initial--and in the case of column (1), long--period of declining incremental ratios followed by a recent and marked increase in the ratios. Evidently, the investment burden per additional ruble of output for transport and communications and for railroad transport is increasing very considerably. What is not clear is why. The contributions to the result of such diverse factors as capital deepening, technical change, economies of scale, the marginal productivity of capital, and the efficiency of economic organization are only summarized in the omnibus variable, the incremental capital-output ratio. On the more complicated question, I am prepared at the moment only to note that a crude adjustment for the role of labor magnifies the change for transport and communications. That is to say, the ratio of the capital increment or investment to the increment in output per worker shows a larger decrease and a larger increase than the ratios in Table 8 for transport and communications.*

*In the case of railroad transport, the decrease is larger with the indicated adjustment, but the increase is smaller. The numerical results are as follows:

	Ratio of Capital Increment to Increment in Output per Worker	Ratio of Investment to Increment in Output per Worker	
		Transport and Communications	Railroad Transport
	(1)	(2)	(3)
1953-1959 Ratio = 1.00			
1928-1940	2.44	-	-
1940-1953	1.83	-	-
1951-1953	-	2.13	2.18
1953-1959	1.00	1.00	1.00
1959-1962	2.20	3.11	1.62
1953-1956 Ratio = 1.00			
1950-1953	-	2.09	1.82
1953-1956	-	1.00	1.00
1956-1958	-	1.22	1.01
1958-1960	-	2.77	1.40
1960-1962	-	3.07	1.52

For a given period with initial and terminal years 0 and t, let K_t = capital at the beginning of year t, and Y_t, I_t, and L_t = output, investment, and employment in year t. The forms of the calculations are:

$$\frac{K_t - K_0}{\frac{Y_t}{L_t} - \frac{Y_0}{L_0}} \quad \text{and} \quad \frac{\sum_{t=0}^{t-1} I_t}{\frac{Y_t}{L_t} - \frac{Y_0}{L_0}} \; .$$

The output, capital, and investment data come from the same sources as Table 8. The employment data, except for 1951 employment, are from [11, pp. 658-659] and [3, p. 453]. The 1951 figure for transport and communications is from [16, p. 60]. I have estimated the 1951 railroad employment figure by using the series in [14, p. 22] as an interpolating index between 1950 and 1952 figures from the foregoing sources.

Appendix

DATA, SOURCES, AND METHODS

This Appendix presents the Soviet data underlying the indexes of transport and communications output, the sources from which these data were obtained, and the methods by which the indexes were constructed. The Appendix consists of seven tables and the notes and sources for each.

Table A-1 presents the basic output series for freight and passenger transport. The alternative sets of weights with which the output series are combined into indexes of transport output are in Table A-2. Table A-3 presents output and employment data for communications.

Given the alternative sets of weights, several indexes of transport output are possible. The annual index on which the text relies is in Table A-4. The major components of that index--freight output, passenger output, and railroad freight and passenger output--are also in Table A-4. Table A-5 presents, for selected years, the alternative indexes of transport output with different 1955 weights. Table A-6 presents, also for selected years, the alternative indexes of freight output that result from the use of weights of the same scope as those underlying Table A-4 but for different dates.

In Table A-7 are two alternative indexes of communications output--one derived from employment data and the other from a combination of employment and ruble output data. This table also presents three variants of the index for transport and communications output, variants that differ because of different communications output indexes or different weights for communications vis-à-vis transport output.

As in the text, all sources cited in the Appendix are cited by numerical references. At the end of this Memorandum is a numbered list of publications cited, from which the specific citation may be identified.

Table A-1

OUTPUT SERIES IN PHYSICAL UNITS, TRANSPORT, 1928-1962

Year	Freight Transport in Billion Ton-Kilometers							Passenger Transport in Billion Passenger-Kilometers				
					Motor							
	Railroad	Maritime	Internal Waterway	Pipeline	Total	General Use	Air	Railroad	Maritime	Internal Waterway	Motor	Air
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1928	93.4	10.1	17.5	0.7	0.2	(.006)	0.00	24.5	0.3	2.1	0.0	0.0
1929	113.0	10.4	20.7	1.1	0.3	(.009)	0.00	32.0	0.4	2.4	(0.1)	0.0
1930	133.9	13.2	(25.4)	2.2	0.5	(.015)	0.00	51.8	0.6	4.0	(0.3)	0.0
1931	152.1	16.0	(29.6)	2.6	0.8	(.024)	0.00	61.8	0.7	4.0	(0.5)	0.0
1932	169.3	20.1	(27.1)	2.9	1.1	(.033)	0.00	83.7	1.0	4.5	0.7	0.01
1933	169.5	24.4	(27.5)	3.4	1.3	(.039)	0.00	75.2	0.9	3.7	(0.8)	0.02
1934	205.7	27.6	(30.5)	3.5	2.4	(.072)	0.00	71.4	0.8	3.0	(1.1)	0.04
1935	258.1	34.1	(35.2)	(3.5)	3.5	(.105)	0.00	67.9	0.9	2.9	(1.4)	0.06
1936	323.4	41.1	(31.8)	(3.6)	5.5	(.164)	0.01	77.2	0.8	2.7	(2.0)	0.08
1937	354.8	36.8	33.3	3.6	5.9	(.176)	0.02	90.9	0.9	3.2	2.2	0.1
1938	370.5	33.9	32.3	(3.6)	6.8	(.203)	0.02	84.9	0.9	3.2	(2.5)	0.1
1939	391.7	(29.8)	34.7	(3.7)	7.9	(.236)	0.02	93.7	0.9	3.3	(2.9)	0.2
1940	415.0	23.8	36.1	3.8	8.9	.266	0.02	98.0	0.9	3.8	3.4	0.2
1945	314.0	34.2	18.8	2.7	5.0	(.185)	0.06	65.9	0.6	2.3	0.5	0.5
1946	335.0	29.4	20.6	2.9	7.5	(.291)	0.08	97.9	1.4	3.2	1.8	1.0
1947	350.5	34.8	25.3	(3.4)	10.6	(.429)	0.09	95.1	1.3	3.1	(2.6)	1.0
1948	446.0	34.8	32.3	(3.9)	13.3	(.562)	0.10	82.5	1.1	2.6	(3.3)	1.1
1949	523.8	37.2	39.1	4.4	17.0	(.751)	0.12	81.3	1.1	2.5	(4.3)	1.1
1950	602.3	39.7	46.2	4.9	20.1	.927	0.14	88.0	1.2	2.7	5.2	1.2
1951	677.3	40.3	51.8	5.5	24.1	(1.089)	0.20	98.5	1.2	2.9	6.5	1.5
1952	741.3	44.3	58.2	6.4	27.6	1.221	0.20	107.4	1.2	3.0	8.4	1.7
1953	798.0	48.2	59.3	7.6	31.4	2.517	0.22	118.3	1.5	3.3	10.5	2.1
1954	856.8	56.6	62.7	10.2	37.5	(4.955)	0.30	129.1	1.4	3.5	14.1	2.4
1955	970.9	68.9	67.7	14.7	42.5	9.261	0.25	141.4	1.5	3.6	20.9	2.8
1956	1079.1	82.4	70.5	20.5	48.5	11.948	0.31	142.4	1.4	3.5	26.4	3.1
1957	1212.8	92.7	76.4	26.6	61.7	14.967	0.34	153.4	1.4	3.8	33.7	4.5
1958	1302.0	106.3	85.5	33.8	76.8	18.394	0.40	158.4	1.4	4.0	42.6	6.4
1959	1429.5	115.7	93.6	41.6	87.6	22.176	0.44	164.4	1.4	4.1	50.7	9.1
1960	1504.3	131.5	99.6	51.2	98.5	27.180	0.56	170.8	1.3	4.3	61.0	12.1
1961	1566.6	159.1	106.0	60.0	105.7	29.266	0.80	176.3	1.3	4.4	69.3	16.4
1962	1646.3	173.4	109.9	74.5	111.9	31.755	0.89	189.3	1.3	4.6	82.2	20.3

Notes and Sources: See next page.

Notes and Sources to Table A-1:

a. The figures in the table do not represent the results of an intensive or extensive search for individual output series. Among Soviet sources available, I have relied almost exclusively on the recent statistical handbooks for ton-kilometer and passenger-kilometer data, especially on Tsentral'noe Statisticheskoe Upravlenie, Transport i sviaz' SSSR, Moscow, 1957; Narodnoe khoziaistvo SSSR v 1960 godu, Moscow, 1961, and Narodnoe khoziaistvo SSSR v 1962 godu, Moscow, 1963. [References 14, 18, and 3.] Obviously, much more careful and exhaustive explorations of the data have been undertaken by others and, in the case of freight transport, the results are available in Ernest W. Williams, Jr., Freight Transportation in the Soviet Union, Princeton University Press, Princeton, 1962. [2]. Considerable use of the latter source was made not only for data unavailable in the recent Soviet handbooks but as a guide through the complexities of the data.

The sources consulted, however, were insufficient to provide series for all years for all carriers. To obtain an annual index for 1928-1940 and 1945-1962, it was necessary to fill the remaining gaps in the output series by interpolations or other, more casual estimates. The data obtained in this way are enclosed in parentheses in Table A-1, unless the magnitudes involved are negligible.

In citing sources for the data in Table A-1, the data obtained directly or by implication from Soviet sources are shown in note b, below, and note c deals with data obtained from [2] or by various kinds of estimates.

b. The following data are stated as such or are implied by the indicated Soviet sources:
Column (1): 1928-1956, from [14, p. 32]; 1957, from [18, p. 531]; 1958-1962, from [3, p. 379].
Column (2): 1932, 1937, 1940, 1945-1956, from [14, pp. 7, 95]; 1957, from [18, p. 531]; 1958-1962, from [3, p. 379]. The 1947-1949 data are converted from nautical miles to kilometers by multiplying by 1.8532.
Column (3): 1937, 1940, 1945, 1950, 1952, 1955, 1958-1962, from [3, p. 379]; 1956-1957, from [18, p. 531]; 1953, from [11, p. 539].
Column (4): 1928, 1932, 1937, 1940, 1945, 1946, 1950-1956, from [14, p. 7]; 1957, from [18, p. 531]; 1958-1962, from [3, p. 379].
Column (5): 1928-1956, from [14, p. 155]; 1957, from [18, p. 531]; 1958-1962, from [3, p. 379].
Column (6): 1940, 1950, 1955, 1956, from [14, p. 165]; 1953, 1957, from [11, p. 576]; 1952, 1958-1962, from [3, p. 409].
Column (7): 1928, 1932, 1937, 1940, 1945, 1950, 1955-1960, from [18, p. 531]; 1952, 1961, 1962, from [3, p. 379]; 1953, from the 1955 figure in Table A-1 and the percentage changes in [11, p. 601]; 1951, 1954, as residuals from total freight in ton-kilometers and itemized components in [14, p. 7].
Column (8): 1928-1956, from [14, p. 32]; 1957, from [18, p. 534]; 1958-1962, from [3, p. 381].

Notes and Sources to Table A-1 (continued):

Column (9): 1928, 1932, 1937, 1940, 1945-1956, from [14, pp. 12, 95]; 1957, from [18, p. 543]; 1958-1962, from [3, p. 381]. The 1947-1949 data are converted from nautical miles to kilometers by multiplying by 1.8532.
Column (10): 1928-1956, from [14, p. 116]; 1957, from [18, p. 534]; 1958-1962, from [3, p. 381].
Column (11): 1928, 1932, 1937, 1940, 1945, 1946, 1950-1956, from [14, p. 12]; 1957, from [18, p. 534]; 1958-1962, from [3, p. 381].
Column (12): 1928, 1932, 1937, 1940, 1945, 1955-1957, from [18, p. 534]; 1952, 1958-1962, from [3, p. 381]; 1946, 1951, 1953, 1954, as residuals from total passenger transport and itemized components in [14, p. 12].

c. The data other than those cited in note b, above, are obtained in various ways as follows:
Column (2): 1928-1931, 1933-1936, 1938-1939. The series for total ton-kilometers in [2, p. 182, column (1)] agrees exactly with those in column (2) for the postwar years through 1960 and for 1932, and yields somewhat smaller 1937 and 1940 figures -- 36.4 and 23.1 -- for reasons that are not specified. Table A-1, column (2), uses the data from [2, p. 182] for 1928-1931, 1933-1936, and 1938-1939. Except for 1928 and 1939, these data are stated as such in Soviet sources; the 1928 and 1939 figures involve estimates (see [2, p. 205]). The 1928 figure from [14, p. 7] is 9.3 and corresponds to none of the data cited by [2].
Column (3): 1946-1949, 1951, 1954. For the postwar years, two series are stated in Soviet sources which differ by small amounts as a consequence of a transfer of certain enterprises to the system in 1957 ([11, p. 539, fn. *]). The two series are, for 1945-1956:

Year	From [14, p. 7]	From [11, p. 539], [18, p. 531], and [3, p. 379]
1945	18.6	18.8
1946	20.4	-
1947	25.1	-
1948	32.1	-
1949	38.8	-
1950	45.9	46.2
1951	51.5	-
1952	57.8	58.2
1953	58.9	59.3
1954	62.4	-
1955	67.4	67.7
1956	70.2	70.5

The data in column (2) for 1946-1949, 1951, and 1954 are obtained by adding to the series from [14, p. 7], 0.2 in 1946-1948, and 0.3 in 1949, 1951, and 1954.

Notes and Sources to Table A-1 (continued):

Column (3): 1928-1936, 1938-1939. For the prewar years also, there are two series that differ by small amounts as indicated in the preceding paragraph. For 1928-1940, the two series are:

Year	From [14, p. 7]	From [11, p. 539]
1928	15.9	15.9
1929	18.3	-
1930	22.7	-
1931	26.8	-
1932	24.9	25.0
1933	25.9	-
1934	29.0	-
1935	34.0	-
1936	31.2	-
1937	33.1	33.3
1938	32.1	-
1939	34.5	-
1940	35.9	36.1

The 1945-1955 series from [14, p. 7] appears in [2, p. 181, column (2)] and is stated there to refer to the ministry and other organizations. (Apparently, the difference between the two postwar series was overlooked by [2], for the somewhat larger postwar figures are used without comment in 1956 and thereafter.) The prewar data from [14, p. 7], or very closely related figures, appear in [2, p. 181, column (1)] and are stated there to refer to the ministry. By 1940, apparently the difference between ministry and ministry plus other organizations is trivial, but the difference is important in 1928 and 1929 ([2, p. 181, columns (1) and (2)]). The following procedure is used to obtain the prewar data in question. The figures in column (3) of the table for 1928 and 1929 are from [2, p. 181, column (2)]. The figure in column (3) for 1937 is, as indicated above, from [3, p. 379]. The 1930-1936 figures in column (3) of Table A-7 are obtained by using the series in [2, p. 181, column (1)] as an interpolating index between the 1929 and 1937 figures. The method of interpolation, developed in [9, pp. 61-68], is described in note b to Table A-3. For 1938 and 1938, add 0.2 to the data from [14, p. 7] -- 0.2 being the difference in 1937 and 1940 between the data in [14, p. 7] and [11, p. 539].

Column (4): 1929-1931, 1933-1936, 1938-1939, 1947-1949. For 1929-1931, 1933-1936, and 1938-1939, the data are from [2, p. 184, series C-50]; the data in parentheses are interpolations in [2]. For 1947-1949, the data represent linear interpolations by the author.

Column (6): 1929-1939, 1945-1949, 1951, 1954. In the absence of any other information, the 1928-1939 figures in column (6) are obtained from the figures in column (5) on the assumption that the 1940 ratio between columns (5) and (6) holds for all years. For the postwar years, the series in column (5) are used as an interpolating index to obtain the figures in column (6): for 1945-1949, the 1940-1950 data are used; for 1951, the 1950-1952 data; for 1954, the 1953-1955 data. The interpolating method is described in note c to Table A-3.

Notes and Sources to Table A-1 (continued):

Column (7): 1929-1931, 1933-1936, 1938-1939, 1946-1949. These are rough interpolations, but cannot be wrong significantly. For 1946, a figure of 0.1 is obtainable as a residual from [14, p. 7]. Also, see [22, p. 501] for evidence that 1932-1935 freight transport is negligible.

Column (9): 1929-1931, 1933-1936, 1938-1939. These are obtained from the 1928, 1932, and 1937 figures in the table by the use of indexes from [21].

Column (11): 1929-1931, 1933-1936, 1938-1939, 1947-1949. The 1929-1931 data are linear interpolations. The 1933-1936 data are rough interpolations on the assumption that the increments in columns (11) and (16) are in stable proportions. The 1938-1939 data are obtained by assuming the same percentage increases in columns (11) and (6). The 1947-1949 data are obtained by using the 1946-1950 series in column (6) as an interpolating index in the manner described in note b to Table A-3.

Column (12): 1929-1931, 1933-1936, 1938-1939, 1947-1949. These are all rough or linear interpolations.

Table A-2

AGGREGATE COSTS OF TRANSPORT, BY CARRIER
(billions of rubles)

Scope of Costs	Freight Transport							Passenger Transport				
					Motor							
	Railroad	Maritime	Internal Waterway	Pipeline	Total	General Use	Air	Railroad	Maritime	Internal Waterway	Motor	Air
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
A. Operating costs												
1955	34.351	1.929	2.065	0.294	33.745	4.705	0.950	9.342	0.173	0.399	1.685	1.060
1950	28.463	1.400	1.597	0.147	-	0.682	0.700	-	-	-	-	-
1960	41.474	2.629	2.333	0.614	-	16.308	1.120	-	-	-	-	-
B. Operating and supplementary costs, 1955, excluding loading and unloading costs and turnover taxes on fuels	39.594	2.322	2.808	0.294	36.687	5.164	1.103	9.825	0.262	0.468	1.893	1.138
C. Operating and supplementary costs, 1955, excluding turnover taxes on fuels	47.463	2.922	3.683	0.294	52.203	7.234	1.438	9.825	0.262	0.468	1.893	1.138
D. Operating and supplementary costs, 1955	47.584	3.000	2.774	0.294	54.640	7.570	1.475	9.844	0.269	0.480	1.983	1.149
E. Operating cost, 1955, excluding taxes on fuels	34.230	1.851	1.974	0.294	29.308	4.369	0.913	9.323	0.166	0.387	1.595	1.048

Notes and Sources:

- Indicates data not available.

For 1955, data on several categories of costs are stated. For 1950 and 1960, data on freight operating costs are stated under operating costs. The origin of these data are described by considering separately, and in turn, the 1955 cost data for carriers other than air, the 1950 and 1960 operating cost data for freight carriers other than air, and the air cost data.

The 1955 cost data other than air: Except for air freight and passenger costs (columns (7) and (12)), the 1955 cost data are from [4, pp. 64, 65-69]. These data are stated as such in [4] except for operating costs excluding turnover taxes on fuel (item E). Turnover taxes on fuels are obtained as the differences between items C and D for each carrier other than air, and are then subtracted from 1955 operating costs (item A) to obtain operating costs exclusive of fuel turnover taxes (item E).

The supplementary costs referred to here appear to represent a variety of outlays depending on the carrier plus freight loading and unloading outlays common to all carriers. In [4, pp. 64-65], the following components of supplementary costs are specified: (a) For railroads, supplementary costs include outlays on the maintenance of the trust responsible for sleeping cars, outlays by railroad offices responsible for dispatching operations and the movement of containers, local outlays on railroad stations and control, and maintenance of spur tracks; (b) For internal waterways, supplementary costs include outlays on maintenance of the waterway and expenditures by the timber industry on the transport of rafts; (c) For maritime transport, supplementary costs include outlays on ports and waterways, and the maintenance of ice-breakers; (d) For automobile transport, supplementary costs include the renovation, repair, and maintenance of roads, and outlays on the transport of loaders and agents; (e) For pipelines, there are no supplementary costs.

(Continued)

Notes and Sources to Table A-2 (continued):

The 1950 and 1960 operating cost data other than air: Except for air freight costs, the 1950 and 1960 cost data are obtained from cost figures per ton-kilometer, multiplied by ton-kilometers hauled and adjusted for certain differences in scope or coverage. The cost data in rubles per ton-kilometer are:

	1950	1955	1960
Railroad	0.05252	0.03932	0.03064
Maritime	0.0374	0.0297	0.0212
Internal waterway	0.0425	0.0375	0.0288
Pipeline	0.030	-	0.012
Motor of general use	0.736	0.508	0.600

The cost figures originate as follows. In [17, p. 620] pipeline costs are stated to be from 0.012 to 0.030 rubles per ton-kilometer in 1956; the larger figure is arbitrarily taken to approximate average 1950 costs and the smaller to approximate 1960 costs. The other 1950 cost figures are from [11, pp. 543, 582] and the other 1960 cost figures are from [18, pp. 534, 562]. The 1955 data are from [18] for motor transport and from [11] for other carriers. (It should be noted that: slightly lower cost figures for internal waterways are stated in [14, p. 24] for 1950 and 1955; and for 1956, the cost data from [17] for carriers other than pipelines agree with those from [11].)

For 1955, these costs per ton-kilometer are multiplied by ton-kilometers hauled from Table A-1 and the results compared with the 1955 operating cost data in item A of this table. The ratios of the figures in the present table to the figures obtained as the products of ton-kilometers hauled and costs per ton-kilometer are: railroad, 0.8998; maritime, 0.9428; internal waterway, 0.8133; and motor of general use, 1.0000. The explanations for ratios different from unity are not clear. The divergence in the case of railroads is at least partly accounted for by a cost-per-ton-kilometer figure that is more comprehensive than operating costs given in the table ([12, p. 475]). Similar explanations may take care of other carriers, or possibly the cost-per-ton-kilometer figures may be somewhat unrepresentative of both the rail and waterway traffic. In the absence of other information, the foregoing 1955 ratios are used as adjustment factors and the relevant ratios for pipelines and airlines are assumed to be unity.

Thus, the freight cost data for 1950 and 1960 (item A) are obtained in two steps: (1) the 1950 or 1960 figure for cost per ton-kilometer is multiplied by 1950 or 1960 ton-kilometers hauled from Table A-1; and (2) the result is multiplied by the adjustment factors obtained here for 1955 -- unity for motor, pipelines, and air freight; somewhat less than unity for the others.

Air freight and passenger costs, 1950, 1955, and 1960: The following information is available on air costs: from [17, p. 620], 1956 cost per ton-kilometer is 3.56 rubles; from oral information obtained by Hans Heymann of The RAND Corporation, from Soviet Aeroflot officials, 1960 costs appear to be about 2.0 rubles per ton-kilometer

Notes and Sources to Table A-2 (continued):

and about 0.15 rubles per passenger-kilometer. To obtain 1955 air freight costs, the ratio of 1955 to 1956 costs per ton-kilometer is observed to be 1.061 for railroads, 1.112 for maritime transport, 1.073 for internal waterways, and 1.043 for motor transport. (The cost figures are from [11, pp. 543, 582] for 1955 and from [11] or [17, p. 620] for 1956. The latter two sources agree on 1956 costs per ton-kilometer except for motor transport and in that case [11] refers to motor transport of general use and [17] to all motor.) On that basis, 1955 air freight cost is taken to be 3.80 rubles per ton-kilometer, or about 1.067 times 1956 cost. 1955 air passenger cost is taken to be 0.38 rubles per passenger-kilometer -- 10 per cent of the freight cost, as against a ratio of 7.5 per cent in 1960. Table A-1 shows that between 1955 and 1960, air ton-kilometers increased 1.24 times and air passenger-kilometers 3.32 times.

Multiplying the indicated 1955 cost figures per ton- and passenger-kilometer by the relevant ton-kilometer and passenger-kilometer figures from Table A-1 and interpreting the results as operating costs, cost figures of 0.950 and 1.060 billion rubles are obtained and shown in columns (7) and (12) (item A) of this table. An adjustment factor of unity is assumed to be applicable to air transport costs. To obtain 1955 air freight and passenger costs, the 1955 operating cost figures are multiplied by ratios expressing the relationship of other cost categories to operating costs for carriers other than air. For example, the operating and supplementary cost figure for air freight transport is the same ratio of air freight operating costs as the ratio of the sum of operating and supplementary freight costs for all carriers excluding air to the sum of operating freight costs for such carriers. The relevant data are in the above table and are applied separately for freight and passenger costs and separately for each category of costs with operating costs taken as unity.

Air freight costs per ton-kilometer for 1960 are stated above as 2.0 rubles and 1960 operating costs (item A) are obtained as the product of this figure and 1960 ton-kilometers from Table A-1. To obtain 1950 air freight costs, the ratio of 1950 to 1956 costs per ton-kilometer is 1.418 for railroads, 1.401 for maritime transport, 1.207 for internal waterways and 1.511 for motor transport. (The cost figures, again, are from [11, pp. 543, 582] and [17, p. 620].) On that basis, 1950 air freight cost is taken to be 5.0 rubles per ton-kilometer or about 1.4 times 1956 cost. Multiplying that figure by the relevant ton-kilometer figure from Table A-1 gives 0.700 billion rubles for 1950 air operating costs in column (7). For both 1950 and 1960 operating costs, as for 1955 operating costs, the relevant adjustment factor is taken to be unity.

Table A-3

COMMUNICATIONS EMPLOYMENT AND OUTPUT, 1928-1962

Year	Employment (millions)	Postal Routes (million kilometers)	Telephones (millions)	Wireless Broadcasting and Receiving Points (millions) 1963 Source	Wireless Broadcasting and Receiving Points (millions) 1959 Source	Letters Sent (millions)	Newspapers and Magazines Sent (millions)	Parcel Post Packages (millions)	Money Orders (millions)	Telegrams (millions)	Intercity Telephone Calls (millions)	Communication Output (billion rubles)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1928	0.095	0.6	0.3	-	0.1	522	1,320	14	17	28	15	
1929	0.120	-	-	-	-	-	-	-	-	-	-	-
1930	0.153	-	-	-	-	-	-	-	-	-	-	-
1931	0.197	-	-	-	-	-	-	-	-	-	-	-
1932	0.224	1.0	0.56	-	1.5	981	4,695	34	38	91	26	-
1933	0.258	-	-	-	-	-	-	-	-	-	-	-
1934	0.295	-	-	-	-	-	-	-	-	-	-	-
1935	0.334	-	-	-	-	-	-	-	-	-	-	-
1936	0.354	-	-	-	-	-	-	-	-	-	-	-
1937	0.375	1.2	0.9	-	3.7	1,277	5,731	31	37	103	50	-
1938	0.439	-	-	-	-	-	-	-	-	-	-	-
1939	0.453	-	-	-	-	-	-	-	-	-	-	-
1940	0.478	1.418	1.225	-	7.0	2,580	6,698	45	99	141	92	5.90
1945	0.426	-	-	-	-	-	-	-	-	-	-	(4.89)
1946	0.468	-	-	-	-	-	-	-	-	-	-	(5.56)
1947	0.486	-	-	-	-	-	-	-	-	-	-	(5.96)
1948	0.499	-	-	-	-	-	-	-	-	-	-	(6.32)
1949	0.515	-	-	-	-	-	-	-	-	-	-	(6.74)
1950	0.542	1.5	1.4	-	11.5	2,607	5,877	44	205	154	103	(7.33)
1951	0.559	-	-	-	-	-	-	-	-	-	-	(7.81)
1952	0.565	1.588	1.598	17.6	-	3,164	7,435	55	-	181	115	8.16
1953	0.582	1.6	1.7	-	17.8	3,275	7,894	59	243	195	119	(8.68)
1954	0.595	-	-	-	-	-	-	-	-	-	-	(9.17)
1955	0.611	1.7	1.9	-	26.5	3,778	9,349	76	256	203	135	(9.73)
1956	0.624	-	-	-	30.9	3,896	10,461	76	262	206	143	(10.27)
1957	0.641	-	-	-	34.9	3,888	11,353	82	281	227	152	(10.90)
1958	0.664	1.855	2.370	51.3	39.2	3,985	12,121	88	293	223	163	11.67
1959	0.691	1.923	2.513	57.5	-	4,103	13,125	91	-	230	172	12.45
1960	0.738	2.242	2.697	63.4	-	4,171	14,403	91	-	241	185	13.51
1961	0.790	2.335	2.932	69.1	-	4,075	15,562	98	-	245	197	14.45
1962	0.832	2.339	3.218	74.2	-	4,239	16,595	107	-	252	210	15.55

Sources:

Column (1): For 1952 and 1958-1962, the data are from [3, p. 453]. For 1928, 1932, 1937, 1940, 1950, 1953, and 1955-1957, the data are from [11, pp. 658-659]. For 1945, the figure is from [19, pp. 204-205]. For 1929-1931 and 1933-1935, the data are from [20, pp. 10-11]. The data for 1936, 1938-1939, 1946-1949, 1951, and 1954 are estimates in [16, p. 60].

Columns (2) and (3): The data are from [3, p. 422] for 1952 and 1958-1962, from [12, p. 520] for 1940, and from [11, pp. 602-603] for 1928, 1932, 1937, 1950, 1953 and 1955-1957.

Columns (4) and (5): The data in column (4) are from [3, p. 422] and in column (5) are from [11, pp. 602-603]. The television and radio transmitting station components appear to be identical in the two series, which differ only in the number of radio receiving points reported. The source of that difference is unexplained.

Columns (6)-(8) and (10)-(11): The data are from [3, p. 422] for 1952 and 1958-1962, from [12, p. 520] for 1940, and from [11, pp. 602-603] for 1928, 1932, 1937, 1950, 1953, and 1955-1957.

Column (9): The data are from [11, pp. 602-603].

Column (12): The data without parentheses are from [3, p. 422] and [12, p. 520]. The data enclosed in parentheses are interpolated by methods described in note c below.

Notes to Table A-3:

- Indicates data not available.
( ) Indicates interpolations (see note c, below).

a. The data in columns (2) through (5) represent crude measures of the extent of particular communications systems and the data in columns (6) through (11) crude measures of particular outputs of the communications systems. Because in-service sectors such as communications employment data are frequently used as a surrogate for output measures, it is relevant to ask whether there is a rough consistency between the changes in employment and the changes suggested by the crude measures of capacity and output.

To explore this question, each of the series is transformed into relatives with 1952 -- and, alternatively, 1955 -- equal to unity. For selected years, the results are shown on the following page. The data indicate a rough consistency in the prewar years in the sense that the prewar employment relatives are within the range of the relatives for the other series. For the postwar years, however, even this rough consistency disappears. The postwar employment relatives show rates of growth substantially smaller than the rates of growth for most of the other series. Only the postwar relatives for postal routes, letters sent, and telegrams are similar to those for employment. Unless communications output is overwhelmingly dominated by these components, one must conclude that employment is a poor surrogate for communications output in the 1950-1962 period.

b. In column (12) are ruble output data without parentheses, to which no explanatory remarks are added by their Soviet sources. If these data are compared with the employment series in column (1), it is clear that ruble output increases more rapidly than employment in all periods represented. The relatives (with 1952 = 1.00) are:

	Employment	Ruble Output
1940	.85	.69
1952	1.00	1.00
1958	1.18	1.43
1962	1.47	1.91

Even the 1940-1952 links indicate a ruble output increase much greater than the employment increase, a result somewhat contrary to the results in note a, above. It is, of course, possible that the ruble data reflect price changes about which, in this sector, we know very little.

Note a, however, suggests that the use of the employment series as a surrogate output measure will substantially understate the increase in output at least in the postwar years; that is, that increases in labor productivity have occurred. In order to derive an alternative output index for communications, it is assumed -- in the absence of any information -- that the ruble data in column (12) for 1940, 1952, and 1958-1962 represent a constant-price output series. It is possible, then, to obtain output values for other postwar years by the use of the employment series as an interpolating index in the manner developed in [9, pp. 61-68]:

RELATIVES OF DATA IN TABLE A-3

Year	Employment	Postal Routes	Telephones	Wireless Broadcasting and Receiving Points		Letters Sent	Newspapers and Magazines Sent	Parcel Post Packages	Money Orders	Telegrams	Intercity Telephone Calls
				1963 Source	1959 Source						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1928	.17	.38	.19	-	-	.17	.18	.26	-	.16	.13
1940	.85	.89	.77	-	-	.82	.90	.82	-	.78	.80
1950	.96	.95	.88	-	-	.82	.79	.80	-	.85	.90
1952	1.00	1.00	1.00	1.00	-	1.00	1.00	1.00	1.00	1.00	1.00
1955	1.08	1.07	1.19	-	-	1.19	1.26	1.38	-	1.12	1.17
1958	1.18	1.17	1.48	2.92	-	1.26	1.63	1.60	-	1.23	1.42
1962	1.47	1.47	2.01	4.22	-	1.34	2.23	1.95	-	1.39	1.83
1928	.16	.35	.16	-	.00	.14	.14	.18	.15	.14	.11
1940	.78	.83	.65	-	.27	.68	.72	.59	.39	.70	.88
1950	.89	.88	.74	-	.43	.69	.63	.58	.80	.76	.76
1952	.93	.93	1.07	-	-	.84	.80	.72	-	.89	.85
1955	1.00	1.00	1.00	-	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1958	1.09	1.09	1.25	-	1.48	1.06	1.30	1.16	1.15	1.10	1.21
1962	1.36	1.38	1.69	-	-	1.12	1.78	1.41	-	1.24	1.56

Notes to Table A-3 (continued):

Let α represent the average annual rate of increase in the output index over a given period and β the average annual rate of increase in employment over the same period, both rates calculated from initial and terminal year values. Let $Y_1, Y_2 \ldots Y_N$ be the output values in years 1, 2 ... N, respectively, and $X_1, X_2 \ldots X_N$ be the magnitudes of employment in the same years. For a given period -- in this case, 1952-1959 -- calculate the α and β that satisfy:

$$Y_1(1 + \alpha)^{N-1} = Y_N$$

and

$$X_1(1 + \beta)^{N-1} = X_N$$

The intervening values of Y are, then, obtained as:

$$Y_2 = Y_1 \cdot \frac{X_2}{X_1} \cdot \frac{1 + \alpha}{1 + \beta} ,$$

$$Y_3 = Y_2 \cdot \frac{X_3}{X_2} \cdot \frac{1 + \alpha}{1 + \beta} ,$$

$$\vdots$$

$$Y_{N-1} = Y_{N-2} \cdot \frac{X_{N-1}}{X_{N-2}} \cdot \frac{1 + \alpha}{1 + \beta} .$$

A slight variant of this procedure is used to obtain the 1945-1951 output figures. Again, the ratio $(1 + \alpha)/(1 + \beta)$ is calculated from output and employment data for 1952-1958. If 1952 is now taken as year N and preceding years as N-1, N-2, and so on, the calculation proceeds as follows:

$$Y_{N-1} = Y_N \div \left(\frac{X_N}{X_{N-1}} \cdot \frac{1 + \alpha}{1 + \beta} \right)$$

$$Y_{N-2} = Y_{N-1} \div \left(\frac{X_{N-1}}{X_{N-2}} \cdot \frac{1 + \alpha}{1 + \beta} \right)$$

and so on.

The data in parentheses in column (12) are obtained by the interpolations (or extrapolations) indicated.

TABLE A-4

INDEXES OF TRANSPORTATION OUTPUT, INCLUDING COMMON-CARRIER MOTOR, 1928-1962

(1955 = 100)

Year	All Freight	All Passenger	Railroad Freight and Passenger	All Transport
	(1)	(2)	(3)	(4)
1928	9.3	14.9	11.2	10.6
1929	11.1	19.2	14.0	12.9
1930	13.4	31.2	18.7	17.4
1931	15.4	36.7	21.7	20.1
1932	16.8	49.0	26.3	24.0
1933	17.2	43.9	25.1	23.1
1934	20.5	41.4	27.5	25.2
1935	25.5	39.9	31.2	28.7
1936	31.1	44.9	37.9	34.1
1937	33.5	52.8	42.4	37.8
1938	34.6	49.8	42.9	37.9
1939	36.1	55.1	45.9	40.4
1940	37.8	58.1	48.4	42.3
1945	29.4	38.8	35.4	31.4
1946	31.2	59.3	41.9	37.4
1947	33.4	58.2	42.8	38.9
1948	41.7	51.7	48.6	43.9
1949	48.9	51.7	54.7	49.5
1950	56.3	56.3	62.0	56.3
1951	62.9	63.7	69.8	63.1
1952	69.5	70.2	76.3	69.6
1953	76.0	79.0	82.5	76.7
1954	85.0	87.9	88.9	85.6
1955	100.0	100.0	100.0	100.0
1956	113.5	104.7	108.9	111.6
1957	129.3	119.6	121.4	127.1
1958	142.7	133.7	129.4	140.7
1959	159.0	150.2	140.6	157.1
1960	173.6	169.1	147.6	172.6
1961	185.7	190.2	153.6	186.7
1962	197.5	217.1	162.0	201.8

Notes and Sources: See next page.

Notes and Sources to Table A-4:

The indexes in Table A-4 are calculated from the output series in Table A-1 and the 1955 operating cost data in Table A-2 (item A). The relevant output series are converted into relatives with 1955 = 1.00 and are combined into indexes through multiplication by the ruble cost data.

In algebraic terms, the indexes are obtained as follows. Let $X_i^{(t)}$ represent the output in ton- or passenger-kilometers of a particular carrier i in year t and $C_i^{(0)}$ the cost per ton- or passenger-kilometer of that carrier in the base year 0 (here, 1955). The indexes, $I^{(t)}$ for year t with year 0 as the base year equal to 100, are then

$$I^{(t)} = \frac{100 \cdot \sum_i \frac{X_i^{(t)}}{X_i^{(0)}} C_i^{(0)} X_i^{(0)}}{\sum_i C_i^{(0)} X_i^{(0)}}$$

Where the indexes in Table A-4 include motor freight transport, they include not total motor transport (column (5) of Table A-1) but motor transport of general use or common-carrier motor transport (column (6) of Table A-1). The output components of each of the indexes in this table are as follows:

Column (1); Table A-1, columns (1), (2), (3), (4), (6) and (7);
Column (2): Table A-1, columns (8), (9), (10), (11), and (12);
Column (3): Table A-1, columns (1) and (8);
Column (4): Table A-1, columns (1)-(4) and (6)-(12).

The corresponding weights are item A of Table A-2: the column numbers for the weights in Table A-2 are the same as the column numbers for the output series in Table A-1 to which they correspond.

Table A-5

INDEXES OF TRANSPORT OUTPUT WITH ALTERNATIVE 1955 COST WEIGHTS, 1928-1962 (1955 = 100)

		1928	1932	1937	1940	1950	1953	1955	1958	1960	1962
All freight, except motor											
Weights A	(1)	10.4	18.8	37.2	41.9	61.8	81.8	100.0	136.0	159.3	180.2
Weights B	(2)	10.6	19.0	37.4	42.0	61.8	81.9	100.0	135.9	159.1	179.9
Weights C	(3)	10.7	19.1	37.4	42.0	61.9	81.9	100.0	135.8	159.1	180.0
Weights D	(4)	10.7	19.1	37.4	42.0	61.9	81.9	100.0	135.8	159.1	180.0
Weights E	(5)	10.4	18.7	37.2	41.9	61.3	81.8	100.0	136.0	159.3	180.0
All freight with common-carrier motor											
Weights A	(6)	9.3	16.8	33.5	37.8	56.3	76.0	100.0	142.7	173.0	197.5
Weights B	(7)	9.5	17.1	33.8	38.1	56.6	76.4	100.0	142.2	172.7	196.3
Weights C	(8)	9.5	16.9	33.3	37.5	55.9	75.6	100.0	143.0	174.5	198.7
Weights D	(9)	9.4	16.9	33.2	37.3	55.7	75.4	100.0	143.3	175.1	199.5
Weights E	(10)	9.4	16.9	33.6	38.0	56.2	76.3	100.0	142.2	172.1	196.3
All freight with total motor											
Weights A	(11)	6.0	11.6	26.8	32.6	55.3	78.3	100.0	155.9	191.6	218.2
Weights B	(12)	6.1	11.7	27.0	32.7	55.4	78.3	100.0	155.7	191.3	216.8
Weights C	(13)	5.8	11.1	26.0	31.8	54.8	78.0	100.0	157.5	194.2	220.3
Weights D	(14)	5.7	11.0	25.8	31.6	54.7	78.0	100.0	158.0	195.0	221.2
Weights E	(15)	6.2	11.8	27.2	32.9	55.0	78.4	100.0	155.1	190.3	215.0
All passenger, except motor											
Weights A	(16)	17.2	56.0	59.3	64.5	61.1	83.4	100.0	122.9	150.3	190.0
Weights B	(17)	17.3	56.3	59.3	64.5	61.2	83.5	100.0	122.9	150.3	190.1
Weights C	(18)	17.3	56.3	59.3	64.5	61.2	83.6	100.0	122.9	150.3	190.1
Weights D	(19)	17.3	56.3	59.3	64.5	61.2	83.5	100.0	122.9	150.4	190.4
Weights E	(20)	17.4	56.0	59.3	64.5	61.1	83.4	100.0	122.9	150.1	189.7
All passenger with common-carrier motor											
Weights A	(21)	14.9	49.0	52.8	58.1	56.3	79.0	100.0	133.7	169.1	217.1
Weights B	(22)	14.9	48.9	52.5	57.8	56.2	78.9	100.0	134.2	170.0	218.4
Weights C	(23)	14.9	48.9	52.5	57.8	56.2	78.9	100.0	134.2	170.0	218.5
Weights D	(24)	14.8	48.6	52.2	57.5	56.0	78.7	100.0	135.3	170.9	219.7
Weights E	(25)	15.0	49.3	53.1	58.3	56.5	79.2	100.0	133.0	168.2	215.6
Railroad freight and passenger											
Weights A	(26)	11.2	26.3	42.4	48.4	62.0	82.5	100.0	129.4	147.6	162.0
Weights B	(27)	11.1	25.7	42.0	48.0	62.0	82.5	100.0	129.7	148.1	162.5
Weights C	(28)	10.9	24.6	41.3	47.3	62.0	82.5	100.0	130.3	149.1	163.5
Weights D	(29)	10.9	24.6	41.3	47.3	62.0	82.5	100.0	130.3	149.1	163.5
Weights E	(30)	11.2	26.3	42.5	48.4	62.0	82.5	100.0	129.4	147.6	162.0
All transport except motor											
Weights A	(31)	11.9	26.8	42.0	46.8	61.6	82.1	100.0	133.2	157.4	182.3
Weights B	(32)	11.9	26.5	41.8	46.5	61.7	82.2	100.0	133.2	157.3	182.0
Weights C	(33)	11.8	25.5	41.2	45.9	61.8	82.2	100.0	133.6	157.5	181.8
Weights D	(34)	11.8	25.5	41.2	45.9	61.8	82.2	100.0	133.7	157.6	181.9
Weights E	(35)	11.9	26.8	42.0	46.8	61.3	82.1	100.0	133.1	157.3	182.1
All transport with common-carrier motor											
Weights A	(36)	10.6	24.0	37.8	42.3	56.3	76.7	100.0	140.7	172.6	201.8
Weights B	(37)	10.7	23.8	37.7	42.2	56.5	76.9	100.0	140.5	172.1	200.9
Weights C	(38)	10.4	22.6	36.7	41.1	56.0	76.2	100.0	141.5	173.7	202.2
Weights D	(39)	10.4	22.5	36.6	40.9	55.8	76.0	100.0	141.9	174.3	203.1
Weights E	(40)	10.6	24.1	38.0	42.5	56.3	77.0	100.0	140.2	171.7	200.6

Notes and Sources: See next page.

Notes and Sources to Table A-5:

This table has two purposes: (1) to present some indexes of different scope from those in Table A-4; and (2) to present the results of the use of alternative 1955 weights. The weights are identified by their item designation in Table A-2: thus, weights A are 1955 operating costs and are the same as used in Table A-4, weights B are 1955 operating and supplementary costs excluding loading and unloading costs and turnover taxes on fuels, and so forth. The form of the index numbers, the base year, and the methods of calculation are the same here as in Table A-4.

The output components of each of the indexes are as follows:

Rows (1)-(5): Table A-1, columns (1)-(4) and (7);
Rows (6)-(10): Table A-1, columns (1)-(4), (6) and (7);
Rows (11)-(15): Table A-1, columns (1)-(4), (5) and (7);
Rows (16)-(20): Table A-1, columns (8)-(10) and (12);
Rows (21)-(25): Table A-1, columns (8)-(12);
Rows (26)-(30): Table A-1, columns (1) and (8);
Rows (31)-(35): Table A-1, columns (1)-(4), (7)-(10), and (12);
Rows (36)-(40): Table A-1, columns (1)-(4) and (6)-(12).

The corresponding weights are in Table A-2: the column numbers for the weights in Table A-2 are the same as the column numbers for the output series in Table A-1 to which they correspond.

The indexes in rows (6), (21), (26), and (36) of this table are the same as those in Table A-4, columns (1)-(4), respectively. They are repeated here for convenience of comparison.

TABLE A-6

INDEXES OF FREIGHT OUTPUT, ALTERNATIVELY WEIGHTED BY OPERATING COSTS OF DIFFERENT YEARS
(1955 = 100)

Year	1955 Weights	1950 Weights	1960 Weights
	(1)	(2)	(3)
1928	9.3	9.1	8.9
1932	16.8	16.5	16.1
1937	33.5	33.1	32.0
1940	37.8	37.4	36.2
1950	56.3	55.8	53.8
1953	76.1	75.5	73.4
1955	100.0	100.0	100.0
1958	142.7	143.3	145.4
1960	173.6	175.0	179.3
1962	197.5	199.1	203.4

Notes and Sources:

This table presents the alternative indexes of freight output, including common-carrier motor, consequent upon the use of operating costs of different years as weights. Column (1) repeats the index in column (1) of Table A-4 -- that is, with 1955 weights from Table A-2. Columns (2) and (3) present the indexes resulting from the use of 1950 and 1960 weights, respectively, from Table A-2. The output components of all three indexes are the same: columns (1)-(4), (6) and (7) of Table A-1. The form of the index numbers and the methods of calculation are the same in this table as in Table A-4 except, of course, that for purposes of the indexes in columns (2) and (3) the output series are transformed into relatives with 1950 and 1960, respectively, equal to unity and the respective weights are applied to those relatives. The indexes in columns (2) and (3) are stated with 1955 equal to 100 in order to facilitate the comparisons and that statement represents only an arithmetic transformation of the results from 1950 or 1960 to 1955 as 100.

Table A-7

INDEXES OF TRANSPORT AND COMMUNICATIONS OUTPUT, 1928-1962

Year	All Transport	Communications		Transport and Communications		
		Employment Series	Combined Employment & Ruble Output	Variant I	Variant II	Variant III
	(1)	(2)	(3)	(4)	(5)	(6)
1928	10.6	15.5	11.4	11.1	10.9	10.7
1929	12.9	19.6	14.4	13.6	13.2	13.0
1930	17.4	25.0	18.4	18.2	17.8	17.5
1931	20.1	32.2	23.7	21.4	20.7	20.4
1932	24.0	36.7	27.0	25.4	24.7	24.3
1933	23.1	42.2	31.1	25.2	24.1	23.8
1934	25.2	48.3	35.5	27.7	26.4	26.1
1935	28.7	54.7	40.2	31.5	30.1	29.7
1936	34.1	57.9	42.6	36.7	35.3	34.9
1937	37.8	61.4	45.2	40.3	39.0	38.5
1938	37.9	71.8	52.8	41.6	39.7	39.2
1939	40.4	74.1	54.5	44.0	42.2	41.7
1940	42.3	78.2	57.5	46.2	44.2	43.7
1945	31.4	69.7	50.2	35.5	33.4	33.1
1946	37.4	76.6	57.1	41.6	39.4	39.2
1947	38.9	79.5	61.2	43.3	41.0	40.9
1948	43.9	81.7	65.0	48.0	45.9	45.8
1949	49.5	84.3	69.3	53.3	51.3	51.3
1950	56.3	88.7	75.3	59.8	58.0	58.0
1951	63.1	91.5	80.3	66.2	64.6	64.6
1952	69.6	92.5	83.8	72.1	70.8	70.9
1953	76.7	95.3	89.2	78.7	77.7	77.8
1954	85.6	97.4	94.2	86.9	86.2	86.4
1955	100.0	100.0	100.0	100.0	100.0	100.0
1956	111.6	102.1	105.5	110.6	111.1	111.1
1957	127.1	104.9	112.0	124.7	125.9	125.8
1958	140.7	108.7	119.9	137.2	139.0	138.8
1959	157.1	113.1	127.9	152.3	154.8	154.5
1960	172.6	120.8	138.8	167.0	169.9	169.6
1961	186.7	129.3	148.4	180.5	183.7	183.3
1962	201.8	136.2	159.8	194.7	198.4	198.1

Notes and Sources: See next page.

Notes and Sources to Table A-7:

a. Table A-7 presents the indexes of transport and communications output derived in the present study. The transport component in column (1) is the transport output index in column (4) of Table A-4, the index obtained with 1955 operating costs as weights. Two communications output indexes are computed: the first is simply the employment series, transformed into relatives with 1955 equal to 100, from Table A-3, column (1); the second is a combination of employment and ruble output series, to be described below. The transport output index and the alternative communications output indexes are combined with alternative weights to obtain the variants of the transport and communications index in columns (4)-(6); the weights and components involved in these variants are described below.

Notes a and b to Table A-3 point out that the prewar employment series bear some rough resemblance to the output indicators assembled but that in the postwar years this resemblance ceases and the ruble output measure in column (12) of Table A-3 diverges from the employment series in the direction suggested by the comparison of the employment series and the output indicators. If one accepts the official ruble output data as a reliable constant-price series and the employment series as a reliable interpolating index used as indicated in note b to Table A-3, the result is an output index for 1940 and 1945-1962. To obtain an index for communications output covering the whole period, the 1928-1940 employment series are linked to the subsequent ruble output data. That is to say, the ruble output data in column (12) of Table A-3 are expressed as relatives with 1940 equal to 1.000 and the prewar employment series in column (1) of Table A-3 as relatives with 1940 equal to 1.000. Treating these as a unified index with 1940 equal to 100, the base year is then shifted to 1955 (equal to 100) in an arithmetic or mechanical manner. The results are in column (3) of this present table.

b. The present question is: What weights can be used to combine the transport and communications output indexes into an index for transport and communications as a whole? One can measure or approximate the relative importance of transport and communications in terms of employment, of capital stock, and of output. The results are as follows:

	Communications	Transport	Transport plus Communications
Employment (millions)	.611	5.039	.108
Capital (billion rubles)	19.9	367.5	.051
Output (billion rubles)	9.73	99.80	.089

These data originate as follows:

(1) The employment data are 1955 data from [19, pp. 204-205].

(2) The capital data are Jan. 1, 1960 data from [10, p. 67].

(3) The output figure for communications is the 1955 figure in Table A-3, column (12). For 1955, transport costs -- operating and

Notes and Sources to Table A-7 (continued):

supplementary costs -- total 77.422 billion rubles (item D in Table A-2). Thus, in terms of output, the relative importance of communications must be less than .11 (9.73 divided by the sum of 9.73 and 77.422). Profits in 1955 for transport and communications combined are 23.44 billion rubles ([18, p.843]). Distributing profits between transport and communications in the same proportions as their capital stock and adding transport profits to transport costs, the ruble output data above and the indicated ratio of communications to total output of .089 are obtained. (Had distributed profits been in proportion to employment, that ratio would have been 0.090.)

Thus, there are three possible sets of weights by which the transport output index and a communications output index might be combined: the weight of communications in 1955 employment is .108, in 1955 output is .089, and in 1960 capital is .051. A separate figure for 1955 communications capital is not available. The employment data, however, show a slight decrease in the relative importance of communications from .108 in 1955 to .105 in 1960. On the assumption that the capital proportions change pari passu, the weight of communications is increased from .051 to .052 as an approximation to the 1955 relative importance of communication capital.

The employment and capital measures are used as alternative limits of a range of weights assumed to resemble value-added weights. We are reluctant to use the output measure -- although it lies within the range of the employment and capital measures -- unless the output data in column (12) of Table A-3 are accepted as the communications output index for the postwar years. Accordingly, the transport and communications output indexes here are obtained as follows:

(a) Variant I (column (4)) is the combination of columns (1) and (2) with employment weights of .892 and .108, respectively;

(b) Variant II (column (5)) is the combination of columns (1) and (2) with capital weights of .948 and .052, respectively;

(c) Variant III (column (6)) is the combination of columns (1) and (3) with output weights of .911 and .089, respectively.

Variants II and III are virtually identical. Variant I shows a somewhat smaller increase than the others, but even here the differences are not appreciable.

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