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CHAPTER 5

Aggregative Growth Trends: Measurement

IT HAS become conventional to summarize industrial growth in the form of an index number, which tells how large production is in any year relative to some base year. By reducing all directions of growth down to a single dimension, an index number obviously serves as a synthetic measure that cannot describe much of what has happened. It amounts to the same thing as measuring one's size by combining together height and weight: the resulting measure would reflect the influence of both fatness and tallness, but it would not reveal how fat or how tall one had become. At the same time, the measure of size could be made to depend more or less on fatness or on tallness by varying the way in which the two were combined together—by changing the factors by which each was multiplied before being added together.

The first principle of index number theory is this: no complex process of growth or change can be uniquely described by a single number. There are many ways of making an index number in order to describe a specific case of growth, and no one of these is inherently better than all the others. There are, of course, always better and worse ways of making index numbers intended for specific purposes, but it is a waste of time all the same to search for the one and only perfect measure, irrespective of purpose.

Having said this much, we must hasten to add that we cannot escape relying on index numbers in one form or another. Every seemingly simple datum is, when analyzed, an index number. The only question is how far we go in aggregation and how careful we are in using the aggregates we create.

The Index Number Problem

The "index number problem" has been thoroughly discussed in the technical literature, and it would be presumptuous and out of place to try to duplicate that discussion here.[1] It may prove useful, however, to summarize the most important issues very briefly before moving on to the matters at hand.

[1] This section is based on the more technical argument in my article, "On Measuring Economic Growth," *Journal of Political Economy* (February 1957, 51–63), where a selected list of pertinent literature is cited. Practical issues in making production indexes are discussed by Solomon Fabricant in *The Output of Manufacturing Industries, 1899–1937* (New York, NBER, 1940, pp. 325–375), and by C. F. Carter, W. B. Reddaway, and R. Stone in *The Measurement of Production Movements* (London, 1947).

A production index is essentially a synthetic measure that translates diverse growth rates for many different products into the single hypothetical rate that presumably would have obtained if, in fact, all products had grown at the same rate. The index tries to answer the question: How much would a standard basket of goods have grown if all the outputs in that basket had remained in the same ratio to each other instead of changing as they did? For example, we may suppose that in one year there are 100 swords and 200 plowshares produced, and in a second year 300 swords and 400 plowshares. How much has aggregate production of both swords and plowshares grown? An answer can be found if the second basket can somehow be turned into a multiple of the first, and this requires that we imagine what would have happened if the ratio of swords to plowshares had remained at 1 to 2 instead of rising to 3 to 4. The ratio has risen because production of swords has grown more percentagewise than production of plowshares. Some of the swords produced in the second year must be conceptually "beaten" into the plowshares that could have been produced in their place if production of both had grown by the same percentage—which is to say, if the ratio of swords to plowshares had remained at 1 to 2. The question then becomes one of determining the number of plowshares that could be produced in place of each forgone sword, given the productive capacity of the economy. That number is defined by the (marginal) cost of producing a sword relative to the (marginal) cost of producing a plowshare. But for which year are relative (or opportunity) costs to be chosen: the first, the second, or some other? Here enters the "weighting problem."

Opportunity costs of production depend on the product mix, the resource mix, and technological conditions. Although the first two factors may be important, we shall ignore them in this elementary discussion.[2] Opportunity costs will tend to fall for those industries experiencing the most rapid technological progress or benefiting most from increased specialization as the economy grows. A "weighting problem" is likely to arise if these same industries also tend to experience either the most or the least rapid growth in output. Such a relation does tend to exist: the industries with the most rapid technological advance and the greatest economies of scale are also most likely to have the most rapid rates of growth in output. Hence a production index constructed with "late-year" costs as weights will typically show a slower percentage rise in aggregate

[2] These and other complications are taken into account in the article referred to in the preceding note.

output than an index constructed with "early-year" costs as weights. This is illustrated in Table 15 through example *A*.

TABLE 15

CONSTRUCTION OF HYPOTHETICAL PRODUCTION INDEXES

	Example A		*Example B*	
	Year One	Year Two	Year One	Year Two
Output of swords	100	300	200	550
Output of plowshares	200	400	100	275
Unit cost of swords	$1	$1	$1	$1
Unit cost of plowshares	$1	$2	$1	$2
Aggregate output				
Year-one weights	$300	$700	$300	$825
Year-two weights	$500	$1100	$400	$1100
Production index				
Year-one weights	100	233	100	275
Year-two weights	100	220	100	275

This would seem to end the matter: a production index is likely to be higher or lower depending on the weights used.[3] But there is more to the problem than this. Suppose, for instance, that in our hypothetical example a different basket of goods had been produced in the first year —say, 200 swords instead of 100, and 100 plowshares instead of 200. This would apparently have been possible with the productive capacity in the first year, since a sword costs the same to produce as a plowshare. Suppose further that both swords and plowshares were to grow at the same percentage rate so that there would be no "weighting problem." It would then be possible to produce 550 swords and 275 plowshares in the second year, a basket of goods that is equivalent to the 300 swords and 400 plowshares in example *A*: 125 plowshares have been exchanged for 250 swords, as permitted by the assumed opportunity costs in the second year. We now observe (example *B*) that the production index would be higher than either of the indexes previously calculated. Why? The answer lies in the fact that in both years the good with declining relative costs (swords) accounts for a larger fraction of aggregate output in example *B* than in example *A*. The index number is therefore seen to depend on the actual productive structure in an economy, or, put another way, on the actual baskets of goods produced.

[3] Only the relative weights are pertinent in determining index numbers. If all unit costs in Table 15 were doubled or halved, the production indexes would not be affected.

There is another sense in which the index number depends on the actual baskets of goods produced, and that has to do with radical changes in the directions of growth. To take an extreme example, let us suppose that in year two the production of swords is discontinued altogether and that a new product, butter, comes to be produced instead. How are we to measure the growth in production? We are faced with metamorphosis rather than growth. It is as if we tried to measure how much a caterpillar grows when it turns into a butterfly. If we use year-one weights, we can measure the decrease in production attributable to loss of swords; if we use year-two weights, we can measure the increase attributable to the addition of butter. But the increase and decrease are not directly comparable because butter has been weighted at a "new" cost, which will probably reflect its abnormally high initial cost of production, whereas swords have been weighted at an "old" cost, which may be either higher or lower than the "new" cost would have been (it is lower in our hypothetical example). Although the technical difficulties are less acute, a similar indeterminateness of index numbers exists if the replacement of one good by another is substantial though not complete, or if there are so-called qualitative changes in existing products. The technical problem discussed here is most troublesome in product areas like machinery, where changes in products occur swiftly in response to changing technology and other economic conditions.

There are no fully satisfactory solutions to the problems we have raised. In practice, we pay considerable attention to the narrow weighting problem because we can observe the effect on index numbers of using different available systems of weights. We cannot observe the effects of industrial structure or directions of growth, because we do not know what alternative structures or directions might have existed or exactly how they would have affected the index number. We are, on the other hand, aware of the enormous measurement problems created when there are radical changes in industrial development, as in the case of industrial mobilization in the United States during World War II.[4] But we cannot calculate alternative index numbers for alternative paths of expansion, as we can for alternative weighting systems.

The inability to "measure" effects of alternative paths of expansion should not be taken to mean that this factor has less effect on production indexes than the system of weights one chooses to use. The question of paths of expansion may be crucial when growth rates in two different

[4] See Geoffrey Moore, *Production of Industrial Materials in World Wars I and II*, New York, NBER, Occasional Paper 18, 1944.

economies are being compared. There is no neutral measure of growth in productive capacity with the same meaning for every economy under all conditions. One economy may, for example, be undergoing a radical metamorphosis while the other is essentially growing in size. Or one economy may be placing heavier emphasis than the other on products whose opportunity costs are falling. And so on. In comparing economies, one must somehow standardize the dimensions in which growth is being measured; the way this should be done will depend on the problems at hand. The job requires patience, judgment, and willingness to work with more than one indicator of growth. These issues are of some importance in comparing the industrial growth of the Soviet Union and the United States, and we shall have more to say about them at a later point.

Up to this point, the problems of constructing index numbers have been discussed in terms of idealized variables. There are, of course, great difficulties encountered in moving to their empirical counterparts: statistics on output and costs will, under the best of conditions, fall far short of what might be ideally desired. It does not need repeating here that Soviet statistics, in turn, fall far short of the best of conditions. We have commented in some detail on the deficiencies of data on output, and it may now be added that the deficiencies are even graver in the case of data on prices and costs, in particular because Soviet prices bear a more or less haphazard relation to costs of production. These and other practical considerations will be taken up in the more concrete discussion that follows.

General Description of Our Indexes[5]

In constructing the indexes for this study, we have necessarily been guided by the peculiarities of Soviet industrial growth and the data available for use. We have considered it advisable to construct several different types of indexes (see Tables 16 and 17), rather than to concentrate on only one. These indexes differ in both weighting systems and product coverage, so that the influence of these factors may be at least partially revealed.

There are three primary variants of product coverage, designed to reflect productive activity within industry[5a] at an intermediate stage of fabrication, at the final stages of industrial processing, and over "all" stages of fabrication and processing. These coverages will be referred to as

[5] The discussion in this and succeeding sections is supplemented in additional detail by technical note 3 of Appendix A.

[5a] Industry includes manufacturing, mining, logging, fishing, and generating of electricity.

TABLE 16

INDEXES OF INDUSTRIAL PRODUCTION: SOVIET UNION, BENCHMARK YEARS, 1913–1955

	Industrial Materials				*Finished Civilian Products*			*All Civilian Products*		
	1913 Weights	1928 Weights	1955 Weights	Moving Weights	1928 Weights	1955 Weights	Moving Weights	1928 Weights	1955 Weights	Moving Weights
					INDEX (1913 = 100)					
1913	100	100	100	100	100	100	100	100	100	100
1928	103	100	99	102	99	92	99	102	107	102
1932	141	131	130	133	126	117	126	144	145	144
1937	249	229	211	233	239	182	239	268	238	268
1940	276	254	232	257	224	173	226	289	231	274
1945	161	148	142	157	92	77	100	167	104	123
1950	364	338	300	331	337	226	295	427	335	397
1955	588	550	463	511	519	353	460	697	488	577
					LINK RELATIVE (INITIAL YEAR OF PERIOD = 100)					
1913–1928	103	100	99	102	99	92	99	102	107	102
1928–1932	136	131	131	131	128	127	128	140	136	140
1932–1937	177	175	162	175	189	156	189	186	164	186
1937–1940	111	111	110	110	94	95	94	108	97	102
1940–1945	58	58	61	61	41	44	44	58	45	45
1945–1950	226	229	210	210	367	295	295	256	323	323
1950–1955	162	163	154	154	154	156	156	163	145	145
1928–1955	569	548	468	502	524	382	465	681	457	563

SOURCE: Appendix D. Military products and miscellaneous machinery are excluded. Current territory except 1913, which covers interwar Soviet territory.

TABLE 17

INDEXES OF PRODUCTION FOR INDUSTRIAL GROUPS: SOVIET UNION, BENCHMARK YEARS, 1913–1955

	INTERMEDIATE INDUSTRIAL PRODUCTS								
	Total			*Ferrous Metals*			*Nonferrous Metals*		
	1928 Weights	1955 Weights	Moving Weights	1928 Weights	1955 Weights	Moving Weights	1928 Weights	1955 Weights	Moving Weights
	INDEX (1913 = 100)								
1913	100	100	100	100	100	100	100	100	100
1928	108	95	108	88	87	88	97	99	97
1932	199	161	199	134	136	134	197	217	197
1937	379	257	379	365	'362	365	567	617	567
1940	434	270	417	375	372	375	844	924	847
1945	302	150	232	236	233	235	617	677	621
1950	682	396	612	541	530	534	1,262	1,407	1,290
1955	1,147	610	942	916	900	907	2,267	2,624	2,405
	LINK RELATIVE (INITIAL YEAR OF PERIOD = 100)								
1913–1928	108	95	108	88	87	88	97	99	97
1928–1932	184	170	184	153	157	153	203	220	203
1932–1937	190	160	190	272	267	272	287	285	287
1937–1940	115	105	110	103	103	103	149	150	149
1940–1945	70	56	56	63	63	63	73	73	73
1945–1950	226	263	263	229	228	228	205	208	208
1950–1955	168	154	154	169	170	170	180	187	187
1928–1955	1,058	644	872	1,046	1,040	1,031	2,336	2,665	2,479

TABLE 17 (continued)

	INTERMEDIATE INDUSTRIAL PRODUCTS								
	Fuel and Electricity			*Chemicals*			*Construction Materials*		
	1928 Weights	1955 Weights	Moving Weights	1928 Weights	1955 Weights	Moving Weights	1928 Weights	1955 Weights	Moving Weights
	INDEX (1913 = 100)								
1913	100	100	100	100	100	100	100	100	100
1928	150	128	150	146	139	146	88	86	88
1932	323	251	323	270	253	270	142	142	142
1937	667	483	667	571	465	571	193	189	193
1940	854	611	849	584	449	565	188	187	189
1945	711	491	682	247	169	213	89	88	89
1950	1,404	909	1,263	1,007	780	981	268	261	264
1955	2,457	1,435	1,994	1,523	1,127	1,418	411	392	396
	LINK RELATIVE (INITIAL YEAR OF PERIOD = 100)								
1913–1928	150	128	150	146	139	146	88	86	88
1928–1932	215	196	215	185	182	185	162	164	162
1932–1937	207	193	207	212	184	212	136	134	139
1937–1940	128	127	127	102	97	99	97	99	98
1940–1945	83	80	80	42	38	38	47	47	47
1945–1950	198	185	185	408	463	463	303	296	296
1950–1955	175	158	158	151	144	144	153	150	150
1928–1955	1,634	1,121	1,329	1,044	810	971	470	455	450

(continued)

TABLE 17 (continued)

CIVILIAN MACHINERY AND EQUIPMENT

	Total			*Transportation Equipment*			*Agricultural Machinery*		
	1928 Weights	1955 Weights	Moving Weights	1928 Weights	1955 Weights	Moving Weights	1928 Weights	1955 Weights	Moving Weights
				INDEX (1913 = 100)					
1913	100	100	100	100	100	100	100	100	100
1928	143	129	143	90	81	90	251	227	251
1932	426	239	426	385	194	385	510	332	510
1937	1,624	499	1,624	2,155	490	2,155	546	516	546
1940	1,178	338	1,140	1,621	402	1,692	279	207	247
1945	500	79	265	715	102	430	65	30	36
1950	2,886	783	2,637	3,810	773	3,250	1,012	804	959
1955	3,475	889	2,994	4,507	820	3,447	1,382	1,032	1,231
				LINK RELATIVE (INITIAL YEAR OF PERIOD = 100)					
1913–1928	143	129	143	90	81	90	251	227	251
1928–1932	299	185	299	430	238	430	203	146	203
1932–1937	381	209	381	560	253	560	107	155	107
1937–1940	73	68	70	75	82	79	51	40	45
1940–1945	42	23	23	44	25	25	23	15	15
1945–1950	577	994	994	533	756	756	1,553	2,648	2,648
1950–1955	120	114	114	118	106	106	136	128	128
1928–1955	2,438	689	2,094	5,030	1,006	3,830	551	455	490

TABLE 17 (concluded)

	CONSUMER GOODS											
	Total			*Food and Allied Products*			*Textiles and Allied Products*			*Consumer Durables*		
	1928 Weights	1955 Weights	Moving Weights	1928 Weights	1955 Weights	Moving Weights	1928 Weights	1955 Weights	Moving Weights	1928 Weights	1955 Weights	Moving Weights
	INDEX (1913 = 100)											
1913	100	100	100	100	100	100	100	100	100	100	100	100
1928	97	110	97	84	82	84	113	132	113	158	122	158
1932	100	114	100	95	97	95	105	123	105	704	327	704
1937	157	168	157	153	139	153	151	182	151	3,652	672	3,652
1940	171	182	171	162	137	156	174	212	175	2,223	436	2,301
1945	72	78	73	73	72	82	71	83	69	352	52	274
1950	194	196	184	183	148	169	187	217	179	6,152	1,093	5,768
1955	331	316	297	279	227	258	337	333	275	16,704	3,098	16,350
	LINK RELATIVE (INITIAL YEAR OF PERIOD = 100)											
1913–1928	97	110	97	84	82	84	113	132	113	158	122	158
1928–1932	103	103	103	113	118	113	93	93	93	446	268	446
1932–1937	157	148	157	161	143	161	144	148	144	519	206	516
1937–1940	109	108	109	106	99	102	115	117	116	61	65	63
1940–1945	42	43	43	45	53	53	41	39	39	16	12	12
1945–1950	269	252	252	252	205	205	264	261	261	1,747	2,119	2,119
1950–1955	171	161	161	152	154	154	180	154	154	272	283	283
1928–1955	340	287	306	331	277	307	298	252	243	10,574	2,537	10,348

SOURCE: Appendix D. These indexes are components of the index for all civilian industrial products. Current territory except 1913, which covers interwar Soviet territory.

industrial materials, finished civilian products, and all civilian products. The specific products covered (see Tables D-10 and D-11 in Appendix D) and weights used have, of course, been delimited by availability of data.

The index for industrial materials is somewhat misnamed, since it covers both intermediate products (as metals, fuels, construction materials, and so on) and "basic" nondurable consumer goods (as flour, butter, fabrics, and so on). Its construction is patterned after the production index designed by Geoffrey H. Moore in his well-known study of industrial production during wartime in the United States.[6] Since this index covers staple commodities that change in nature only very slowly, its movements are not seriously disturbed by radical changes in the mix of more highly fabricated products.

The index for finished civilian products measures the output of the "final" products of industry, so to speak. It covers transportation and agricultural equipment, construction materials, and both durable and nondurable consumer goods. It does not cover military end items or the more heterogeneous types of machinery. Even with these exceptions, the list of "final" products is by no means exhaustive, and some of the products included (as construction materials) are consumed in part within industry. The coverage it attempts to make is at best only reasonably approximated. Finally, it should be noted that various stages of fabrication are represented, up to the most advanced.

The index for all civilian products is designed to give a comprehensive coverage of industry, including products of all kinds for which reasonably continuous output data and needed weight factors are available. As in the case of the index for finished civilian products, military end items and heterogeneous categories of machinery are not included in the basic indexes. They have, however, been included in derivative indexes that will be explained in a later section.

The weighting systems used are in many fundamental respects the same, but they, too, have been tailored to the needs of the data and the scope of each index. For industrial materials, the output of each product has been weighted by its unit value as of a weight-base year. Each unit value was calculated to exclude, through several estimative procedures, the cost of nonindustrial materials consumed in fabricating the product. This adjustment makes the unit weights approximate the costs of purely industrial activities, though in some cases an unknown degree of double counting remains because some of the products in the index are used

[6] Cited in footnote 4 above.

in producing others. That is to say, the net value weights for some products include values already counted for other products. It was not feasible to eliminate this double counting, which is probably not serious enough to make the resulting index significantly different from what it would have been if more accurate weights had been used. In any case, we followed the procedure originally used by Geoffrey Moore in his production index for industrial materials in the United States.

In order to study the effect of different sets of weights, several weight-base years were used, and unit weights were taken from industry in the United States as well as in the Soviet Union. Three weight bases were used for the Soviet Union: 1913, 1928, and 1955; four were used for the United States: 1914, 1929, 1939, and 1954 (see Table 21). A moving-weight index (see Table 16) was also formed by chaining together four links taken from the indexes with Soviet weights: for 1913–1928, the geometric average of indexes with 1913 and 1928 weights; for 1928–1937, the index with 1928 weights; for 1937–1940, the geometric average of indexes with 1928 and 1955 weights; and for 1940–1955, the index with 1955 weights.

The unit weights used for finished civilian products were derived in the same way as those used for industrial materials. Indexes were constructed with 1928 and 1955 weights, and these were combined into a moving-weight index in the manner already discussed, except that the link for 1913–1928 was taken as the index with 1928 weights. Weights for the United States or for an earlier year were not used because the matching of products in the machinery sector would have been arbitrary.

For all civilian products, we used a composite system of Soviet weights similar to that used in making comprehensive production indexes in Western countries. Outputs of products within industrial groups were combined together by unit weights derived in the manner described above. Outputs of industrial groups, which were as narrowly defined as the needed weights permitted, were then combined by value added for the 1928 weight base, and by employment for the 1955 weight base.[7] A moving-weight index was constructed in the same manner as for finished civilian products.

[7] Output of each product may be expressed in any convenient unit of measure. If output is expressed as an index number (as for a group of products), the unit of measure is the volume of output—perhaps a weighted aggregate—in the comparison-base year. A weight must, of course, be applicable to the unit of measure for the product or group of products that it is attached to, and all weights must be expressed in the same unit of measure (as dollars). This unit of measure, too, may be arbitrarily chosen since only relative weights matter. For example, each weight may be expressed as a percentage of some (any) number.

Details on Weights and Weighting Systems

DERIVATION

Soviet weights are derived from official statistics covering both large- and small-scale industry. They are listed and explained in Tables D-8 and D-9 of Appendix D. For 1928, the basic data have been derived primarily from censuses and annual surveys of industry covering 1926/27, 1927/28, and 1928/29. Since the annual survey for 1927/28 was limited in its industrial coverage and in the types of data published, it was necessary to make adjustments and additional estimates (discussed in Table C-2 of Appendix C) on the basis of statistics for the two adjoining years. Wherever possible, weights were derived as physical output (of a product or group of products) divided into the relevant value of output or value added. For a number of narrowly defined products, we had to compute weights from official price lists, often using medians or averages—wherever possible, weighted averages—of prices for even more narrowly defined products. Some weights were derived quite indirectly, on the basis of information for years rather distant from 1928 and such linking factors as were available. We consider these to be the least bad weights that can be devised but they are far from ideal. They apply to the following products: natural gas, ground natural phosphate, automobiles, locomotives (steam, diesel, and electric), railroad freight cars, street and subway rail cars, paring plows, and phonographs.

The Soviet value weights for 1913 and 1955 are derived almost exclusively from official price lists. The prices for 1913 are those devised by Soviet statisticians during the early 1920's to be used in comparing postrevolutionary production with the prerevolutionary level, and as such they have been adjusted to apply to production within the interwar Soviet territory. Except for consumer goods, the prices for 1955 are taken primarily from price handbooks. The prices of consumer goods were derived from several sources and often indirectly. If only a retail price was available, it was reduced by 10 per cent to eliminate trading costs. In the absence of more detailed information, the cost of nonindustrial materials was estimated in many cases to be the price times the ratio of cost of materials (including scheduled amortization of equipment) to total "cost" as defined in Soviet statistics, total "cost" being wages plus cost of materials. Since price includes profits and—in the case of consumer goods—turnover taxes, a fraction of these items equal to the cost ratio was also eliminated. In some cases (hard leather, soft leather, flour, vegetable oil, canned food, beer, cigarettes, and low-grade tobacco), the

cost ratio was taken for 1934, the closest date for which it was available. The special problems connected with the elimination of turnover taxes and profits are discussed in the next section. Aside from the products already mentioned, those with weights most indirectly derived for 1955 are petroleum, all types of mineral fertilizer, starch and syrup, and candy.

The 1955 employment weights used in the index for all cilivian products are based on the percentage distribution of production workers (*promyshlennye rabochie*) among industrial groups, the only such distribution so far published in official Soviet statistics. Production workers are presumably wage earners directly engaged in manufacturing and extractive activities. So-called auxiliary workers, salaried employees, and maintenance and overhead personnel are not counted as production workers. This is obviously a restricted definition of industrial employment, and the percentage distribution may not accord well with one for employment more satisfactorily defined.[8] Unfortunately, as beggars for statistics we cannot choose.

WEIGHTS AND COSTS OF PRODUCTION

As pointed out at the beginning of this chapter, relative weights used in most general-purpose production indexes are supposed to represent relative costs of production. In a highly developed market economy, it is taken for granted that market values—price, unit value added, and so on—approximate relevant costs.[9] This cannot be taken for granted in the Soviet system.

Now that discussion of the subject is no longer forbidden, there has been a growing volume of Soviet literature criticizing the failure of prices to reflect cost of production.[10] Since the critics are influenced by Marxist economic theory—or at least terminology—it is not always clear what they mean by "cost of production." However, there is no doubt from the examples they cite that many Soviet relative prices have no relation whatever to opportunity costs. This is particularly true of prices of consumer goods taken relatively to prices of most other things, because

[8] For 1933 and 1935, percentage distributions of production workers and engaged persons are compared in the notes to Table C-1 in Appendix C.

[9] For a dissenting view, see Joan Robinson, "Mr. Wiles' Rationality: A Comment," *Soviet Studies*, January 1956, pp. 269–273. She argues that prices do not always equal costs in a market economy, and therefore they are no more useful as a measure of cost than in a planned economy. In other words, black is not different from white because both are shades of gray.

[10] For a sample of the Soviet discussion of prices and costs, see *Current Digest of the Soviet Press*, IX, 14 and 34.

turnover taxes—usually at least equal to "costs" of production—apply to the former but not to the latter.[11] It is also true of many relations among prices not directly subject to turnover tax, because of the labyrinth of differential subsidies and taxes established over the years.

In a recent study, Professor Lynn Turgeon concludes that, for a group of sixteen intermediate industrial products, prices more closely approximated "costs" in 1927/28 and 1955 than in any intervening year for which data were available.[12] This much seems to favor our choice of weight bases. However, we must recognize that the Soviet measure of "cost" does not include any imputed return on capital. Nor does it include any subsidies given to, or exclude any special levies made on, the materials consumed by a product in question. Moreover, the "costs" of a product are computed on an average basis for all enterprises producing it, under conditions in which little effort is made to equalize the marginal cost among enterprises, even as cost is defined in the Soviet Union. Finally, Turgeon's study is based on a limited sample of a limited category of products; it does not cover the area of finished goods where discrepancies between cost and price are likely to be the greater.[13]

We have made adjustments to help correct the distortions imposed by excise and turnover taxes. For 1928, we have eliminated excise taxes, which were generally low, from all value data—except for the few possible cases in which the amount of tax may not have been published. For 1955, our procedure for eliminating the costs of nonindustrial materials (see the preceding section) amounts in effect to eliminating a fraction of turnover taxes and profits equal to the ratio of the cost of materials to total "cost" (i.e., combined wages and cost of materials).[14] The remaining turnover tax and profits—a fraction equal to the ratio of wages to total "costs"—is in effect treated as a return on capital and left within the adopted unit value. This procedure is obviously arbitrary, but it seems less bad than the alternatives available.

As a practical matter, the bulk of turnover taxes and profits was eliminated in this way. For a group of twenty-four consumer products, the smallest fraction eliminated was 64 per cent; the median fraction, 88 per

[11] Turnover tax rates have not been systematically published for recent years, but rates for the interwar period have been compiled by N. Jasny in *The Soviet Price System*, Stanford, 1951, pp. 164 ff, and F. Holzman in *Soviet Taxation: The Fiscal and Monetary Problems of a Planned Economy*, Cambridge, Mass., 1955, p. 151.

[12] Lynn Turgeon, "Cost-Price Relationships in Basic Industries during the Planning Era," *Soviet Studies*, October 1957, p. 157.

[13] *Ibid.*, p. 145.

[14] Turnover tax rates are known for salt, soap, and rubber footwear, so that the full amount of tax was eliminated in these cases.

cent.[15] If we might assume that the median turnover tax was about 60 per cent of the wholesale price, the median amount remaining after our adjustment would be about 7 per cent of the wholesale price.

All things considered, we may conclude that the Soviet weights for 1913 and 1928 are reasonable approximations to costs of production, in the latter year because the market still played a substantial role in the Soviet economy. The weights for 1955 are another matter. Within industrial groups composed of closely related industries (as ferrous metals, nonferrous metals, textiles, and so on), they may reflect opportunity costs reasonably well; between industrial groups, they may do so less well. It is even doubtful whether the use of employment as a weight factor for industrial groups improves the situation, not only because employment is merely an estimate of value added (on this, see more below), but also because there is little reason to presume that labor is economically allocated among industries.[16] Whether the weights reflect opportunity costs or not, the only way to find out the effect of a given set on production indexes is to use it and compare the result with those obtained from other sets. We shall present evidence of this sort below.

DIRECT AND IMPUTED WEIGHTS

A production index constructed from ideal data would require infinite detail in both product breakdown and weights. In practice, we have at our disposal only samples of both types of data, which may be more or less representative of the ideal information. Each output series is merely an index or indicator of the behavior of the many subseries included within it. Similarly, the weight attached to each series is a composite of many weights applying to the many subseries taken to be represented by the single indicator. The problem of matching weights and output series is the index number problem in miniature, so to speak. The difficulties here are usually discussed under the question of whether direct or imputed weights are to be used in constructing an index.

[15] The fractions eliminated were as follows (per cent):

Soap	100	Linen fabrics	91	Silk fabrics	80
Salt	100	Candy	90	Knitted goods	78
Rubber footwear	100	Sugar	90	Hosiery	78
Meat	96	Cotton fabrics	89	Canned food	78
Woolen fabrics	93	Vegetable oil	87	Beer	78
Vodka	93	Boots and shoes	87	Hard leather	75
Butter	92	Cigarettes	80	Soft leather	75
Flour	92	Tobacco	80	Matches	64

[16] See P. J. D. Wiles, "Are Adjusted Rubles Rational?" *Soviet Studies*, October 1955, especially pp. 145–148.

It is, of course, clear that the directness of a weight is a matter of degree. We are not in fact faced with a simple choice between direct and imputed weights, but rather with the choice of how the imputation is to be done. And in every case the choice must be made within the framework of available alternatives.

Let us illustrate the issues with a concrete example. We may consider the group of products included within "ferrous metals." Suppose we let this group be represented by three products: iron ore, steel ingots, and rolled steel products. Each of these products contains a large number of identifiable subproducts, and a weighted production index made up from the subproducts, if feasible, would not necessarily behave in the same way as the physical output of the composite indicator. That is to say, a weighted production index of all rolled steel products would not necessarily change percentagewise in the same way as output of all rolled products expressed in metric tons. It then follows that a production index for ferrous metals made up by weighting the three products (iron ore, steel ingots, and rolled steel products) may differ significantly from one made up by weighting all the subproducts. Moreover, there remains the question whether the production index for ferrous metals is to be considered as applying only to the products explicitly covered or also to other miscellaneous products not explicitly covered but generally classified in that category, a question that arises when a weight must be chosen for ferrous metals as a whole in order to construct a production index for all industry. Should the weight be a direct one—i.e., should it be restricted to the products explicitly covered by the production index? Or should it be an imputed one—i.e., should it extend over a group of products considered to be implicitly if not explicitly covered? These same questions could, of course, arise at any level, for "products" as well as "product groups." They are most serious in areas like machinery, which will be discussed separately below.

We have adhered to the rule of using direct weights wherever feasible. Table A-6 in Appendix A outlines the adjustments made in value added for 1928 to bring the weights in the index for all civilian products closer to a direct basis. This procedure amounts to making the production index apply rather strictly to the sector of productive activity actually encompassed by the data used. It applies to "all" industry only if one assumes that the residual of uncovered activity behaved in the aggregate the same as the total covered activity. Particularly in the face of deficient Soviet statistics, we have considered this to be more likely than that the uncovered activity in each separately defined industrial group behaved

the same as the covered activity in that group alone. If the latter were considered more likely, the proper procedure would be to impute the full weight for an industrial group to the covered activity within it. We have avoided this kind of imputation wherever possible because it seems reasonable to presume that those products whose output has been published have generally shown a more rapid growth than the related products whose output has not been published—except where the latter have been directly connected with the military effort. Hence, in our opinion, the use of imputed weights introduces an upward bias into indexes of Soviet production.

One notable exception to our rule occurs in our index for all civilian products with 1955 weights. The breakdown of employment was available only for broad industrial groups, and it was impossible to determine the employment applying to our coverage alone. Employment in the printing industry and in other unspecified industries (4.2 per cent of the published total) was not included in our weights, and minor adjustments were made to make the Soviet categories correspond to ours (see Table D-9 in Appendix D). But there remains an unknown degree of imputation of weights to broad industrial groups. The effect on our production index must also remain unknown, though some evidence on the general adequacy of employment weights will be presented below.

We can illustrate the effect of replacing direct with imputed weights in our index for all civilian products with 1928 weights. As imputed weights, we use the total value added for product categories (except miscellaneous machinery) given in detail in Table C-2 of Appendix C and summarized for industrial groups in Table A-6 and the surrounding text of Appendix A. The resulting index compares as follows with the index using direct weights:

	Direct Weights	*Imputed Weights*	*Ratio, Imputed to Direct*
1913	100	100	1.00
1928	102	103	1.01
1937	268	284	1.06
1940	289	298	1.03
1955	697	754	1.08

Imputed weights therefore cause the index to rise somewhat more rapidly than direct weights, the greatest divergence applying to the period 1928–1937.[17]

[17] Similar examples of the effects of imputation on production indexes for the United States and the United Kingdom are given in Moore, *Production of Industrial Materials*, pp. 61 ff, and in C. F. Carter and M. Robson, "A Test of the Accuracy of a Production

GROSS AND NET WEIGHTS

The nature and purpose of a production index determine how "gross" or "net" weights should be. It would be misleading to lay down an ironclad rule that "value added" should always be used, because the important issue is what the "value added" is to be computed for. Here, again, the problems are best illustrated by concrete examples.

What weight factor should be applied to the output of steel ingots? This all depends on what that output is taken to represent. In our index for industrial materials, the output of steel ingots is taken to represent all productive activities devoted to making steel ingots that fall within the boundaries of industry, except what is counted elsewhere in the index. Hence the weight should be the price of steel ingots minus the cost (per unit of steel ingots) of nonindustrial ingredients and industrial ingredients treated elsewhere as components of the index. In practice, we have been able to eliminate the former but not the latter.

In the index for all civilian products, on the other hand, the output of steel ingots is taken to represent productive activity only at the last identifiable stage of fabricating ingots, activity at other stages being represented by other output series. In this case, the weight should be the price minus the cost of all ingredients produced elsewhere.[18]

Production indexes attributed to segments of industry will mean different things under these two approaches, and they are quite likely to show substantially different behavior. In the case of intermediate industrial products an index calculated by the method used for industrial materials differs markedly from one calculated by the method used for all civilian products (see Table 18). With 1928 weights, the latter rises much faster than the former between 1913 (or 1928) and 1955; with 1955 weights, much slower. The discrepancies between the two types of indexes cannot be attributed solely to differing weighting systems, since the scope of productive activity covered also differs. If each type of index were assumed to measure accurately what it is designed to measure, the discrepancies would have to be attributed to that difference in scope.

Index," *Journal of the American Statistical Association*, March 1956, 17–23. When elaborate data are available, as in U.S. censuses, refined imputations may be made. See, e.g., the coverage adjustment in Fabricant, *Manufacturing Industries*, pp. 362 ff.

[18] We have found it necessary in some cases to tailor the output series to the available weight instead of the reverse. For example, our series on vegetable oil covers total output including oil consumed in producing oleomargarine. Since we were unable to adjust our 1955 Soviet weights to eliminate double counting of the oil used in margarine, we constructed a new series on vegetable oil excluding the estimated consumption in oleomargarine. Similar adjustments were made for sulfuric acid and raw sugar.

TABLE 18

PRODUCTION OF INTERMEDIATE INDUSTRIAL PRODUCTS AS REPRESENTED BY TWO DIFFERENT TYPES OF INDEXES: SOVIET UNION, SELECTED YEARS (1913 = 100)

	1913	1928	1955
1928 weights			
Industrial materials index	100	106	880
All civilian products index	100	108	1,147
1955 weights			
Industrial materials index	100	101	804
All civilian products index	100	95	610

SOURCE: Appendix D.

We would then conclude that productive activity grew less rapidly through an intermediate stage of fabrication than it did through a more advanced stage when calculated in terms of 1928 opportunity costs, but more rapidly when calculated in terms of 1955 opportunity costs. This conclusion must, of course, be conjectural and question-begging since we have no way of determining whether each of the indexes being compared is "correct"—this is, in fact, the basic question we start and end with.

In short, there is no conclusive a priori or experimental test of the correctness of a weighting system. The best we can do is make sure that the method of selecting weights is reasonable for the purpose in view. Results of different approaches may then be compared, but no definitive rationalization of discrepancies is justified.

WEIGHT BASES

A production index may be constructed with a fixed or a moving weight base. The fixed base may be a single year or an average of two or more years. An index constructed with a moving weight base is simply formed by chaining together links, each constructed with a fixed base.

As we stated earlier, it has frequently been observed that, for rapidly growing economies, an industrial production index constructed with an early-year weight base rises significantly more rapidly than one constructed with a late-year weight base. Professor Alexander Gerschenkron has, in particular, called attention to this phenomenon.[19] He gives several

[19] Alexander Gerschenkron, *A Dollar Index of Soviet Machinery Output, 1927–28 to 1937*, RAND Corporation, Santa Monica, 1951, pp. 47–58. See also *Census of U.S. Manufactures, 1954, Indexes of Production*, Washington, 1958, pp. 20 ff, where it is also argued (pp. 24 ff) that this is, at least in part, a stochastic phenomenon, owing to the interdependence of outputs and weights.

examples for indexes of machinery, and we shall cite one. If comparable items of U.S. machinery are weighted in 1899 and 1939 prices, output is shown as multiplying more than fifteen times between 1899 and 1939 with 1899 weights, and less than twice with 1939 weights.[20] This enormous discrepancy reflects more than the effect of weights; it also reflects the inherently arbitrary nature of any measure of machinery production. But it is a striking example of how the combined difficulties in defining products and in choosing appropriate weights may lead to virtually contradictory index numbers when resolved differently.

TABLE 19

EFFECT OF WEIGHT BASE ON PRODUCTION INDEXES FOR SOVIET INDUSTRY AND INDUSTRIAL GROUPS

	Production in 1955 (1913 = 100)			*Ratio*		
	1928 Weights (1)	1955 Weights (2)	Moving Weights (3)	(1)/(2)	(1)/(3)	(2)/(3)
Industrial materials[a]	550	463	511	1.19	1.08	0.91
Finished civilian products	519	353	460	1.47	1.13	0.77
All civilian products	697	488	577	1.43	1.21	0.85
Ferrous metals	916	900	907	1.02	1.01	0.99
Nonferrous metals	2,267	2,624	2,405	0.86	0.94	1.09
Fuel and electricity	2,457	1,435	1,994	1.71	1.23	0.72
Chemicals	1,523	1,127	1,418	1.35	1.07	0.79
Construction materials	411	392	396	1.05	1.04	0.99
Transportation equipment	4,507	820	3,447	5.50	1.31	0.24
Agricultural machinery	1,382	1,032	1,231	1.34	1.13	0.84
Food and allied products	279	227	258	1.23	1.08	0.88
Textiles and allied products	337	333	275	1.01	1.23	1.21
Consumer durables	16,704	3,098	16,350	5.39	1.02	0.19

SOURCE: Tables 16 and 17.

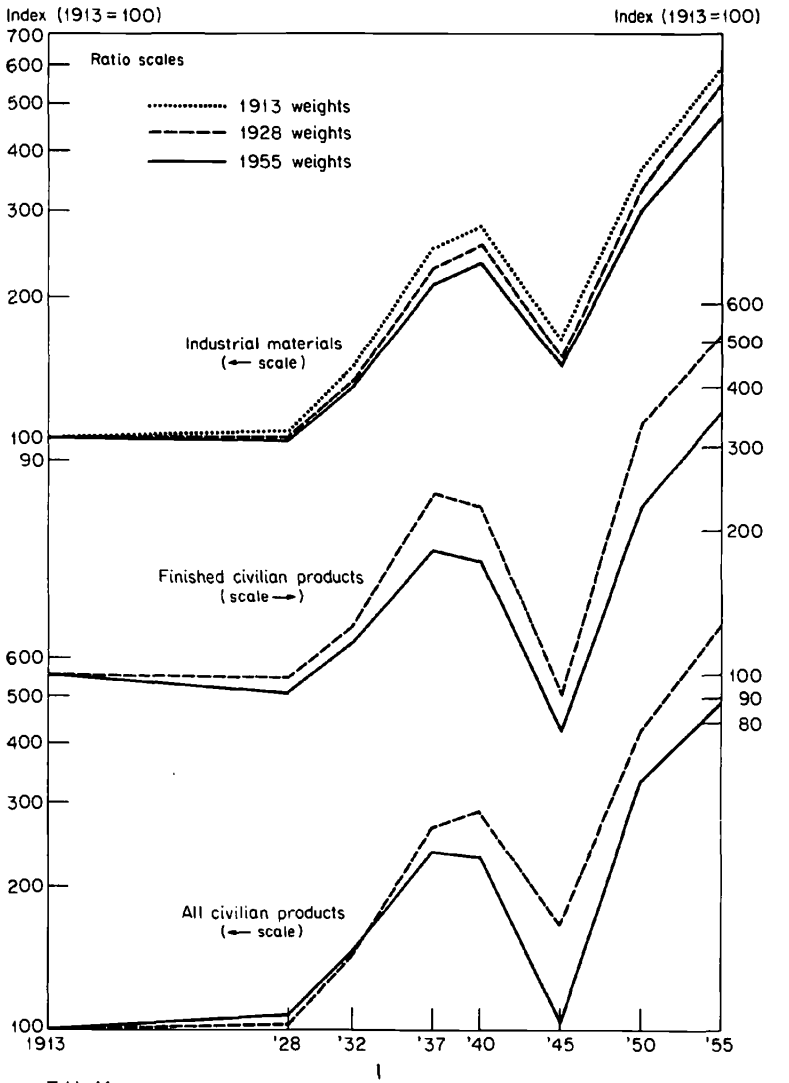
[a] With the same product coverage, production indexes based on 1913 and 1928 weights are, respectively, 588 and 513. The ratio of the former to the latter is 1.15.

Some of the differences in production indexes for Soviet industry based on 1928 and 1955 weight bases are summarized in Table 19 and Chart 11. For the entire Soviet period, all but one of the indexes shown (that for nonferrous metals)[21] is higher when based on 1928 weights than when

[20] Gerschenkron, *Soviet Machinery Output*, p. 52. For other, less spectacular examples, see *Census of U.S. Manufactures, 1947, Indexes of Production*, p. 4; *Census of U.S. Manufactures, 1954, Indexes of Production*, p. 20; Carter and Robson, "Accuracy of a Production Index," p. 21; and *A Critique of the United States Income and Product Accounts*, Studies in Income and Wealth 22, Princeton for NBER, 1958, pp. 419 ff.

[21] In this case, it may be that depletion of better-grade ores has more than offset other (relative) cost-reducing factors, such as increased productivity of resources other than mining property.

CHART 11
Indexes of Soviet Industrial Production, Grouped by Scope, Benchmark Years, 1913–1955



Source: Table 16.

based on 1955 weights. The percentage discrepancies are largest for transportation equipment, consumer durables, fuel and electricity, and chemicals; they are smallest for textiles and allied products, ferrous metals, and construction materials. As to the aggregate indexes, the

discrepancy is largest for finished civilian products, next largest for all civilian products, and smallest for industrial materials. To an unknown but probably minor extent, the discrepancies may reflect differences in product coverage, since this varies somewhat in most cases with the weight base (see below).

The indexes based on 1928 and 1955 weights are also compared with moving-weight indexes. While a moving-weight index is a kind of average of fixed-weight components, in one case shown here (textiles and allied products) it is lower than both counterpart fixed-weight indexes. This result—or the reverse, with the moving-weight index higher than both fixed-weight counterparts—can easily occur, depending on how the two fixed-weight indexes behave relative to each other over the links they are taken to represent in the moving-weight index.

ADEQUACY OF EMPLOYMENT WEIGHTS

As we have already noted, the index for all civilian products with 1955 weights has been constructed by weighting industrial groups by employment. The question naturally arises as to how much difference there would have been if value-added weights had been used. Since such weights are not available, we cannot give a direct answer to this question, but we can find out how our index with 1928 weights would be affected if employment weights were substituted for value-added weights.

For these special computations, we derived both direct and imputed 1928 employment weights, corresponding in coverage to the value-added weights already discussed.[22] The index with direct weights is designed to parallel our index with 1928 direct value-added weights, the direct employment weights being applied to the narrowest product categories for which they are available and those product categories being internally weighted by 1928 unit values. The index with imputed weights is designed, on the other hand, to parallel in construction our index with 1955 employment weights, the imputed weights being applied to broad industrial groups internally weighted by 1928 unit values. Two variants of the latter index were prepared, differing in their treatment of weights for transportation equipment, agricultural machinery, and consumer durables. In the first variant, we used the imputed employment weight for each category as derived from detailed 1928 data; in the second, we prorated the total weight for all machinery and metal products to each category by its computed 1928 value of output. The latter procedure

[22] The employment weights are set forth and described in Table A-7 and the surrounding text of Appendix A.

was used in our index with 1955 weights because employment was not available for categories of machinery.[23] The second variant, therefore, parallels our method of constructing the index with 1955 weights more closely than the first variant does.

In Table 20, indexes with alternative 1928 employment and value-added weights are compared. The two indexes with direct weights show

TABLE 20

COMPARISON OF PRODUCTION INDEXES FOR SOVIET CIVILIAN INDUSTRIAL PRODUCTS: 1928 VALUE-ADDED AND EMPLOYMENT WEIGHTS, SELECTED YEARS, 1913–1955
(1913 = 100)

	1913	1928	1940	1955
Value added weights				
Direct	100	102	289	697
Imputed	100	103	298	754
Employment weights				
Direct	100	106	299	703
Imputed, first variant	100	103	278	682
Imputed, second variant	100	106	306	777

SOURCE: See text.

about the same growth over the period 1913–1955. In the case of indexes with imputed weights, the first variant with employment weights rises more slowly than the index with value-added weights, but the second variant rises more rapidly. We may surmise that our index with 1955 employment weights might also rise faster than one using value-added weights, could the latter be constructed. Such an inference is, of course, highly tenuous and cannot be asserted with confidence. In any event, there is no convincing evidence available that an index based on imputed employment weights is likely to diverge significantly, in one direction or the other, from one based on direct value-added weights.

WEIGHTS FROM UNITED STATES INDUSTRY

Production indexes for industrial materials based on U.S. weights are compared in Table 21 with indexes based on Soviet weights. For these comparisons, all indexes have been adjusted to an identical product coverage (forty-nine products), which means that the following five products have been eliminated from the indexes with Soviet weights: oil shale, peat, firewood, plywood, and beer.

[23] See Table D-9 in Appendix D.

TABLE 21

COMPARISON OF PRODUCTION INDEXES FOR SOVIET INDUSTRIAL MATERIALS: SOVIET AND U.S. WEIGHTS, BENCHMARK YEARS, 1913–1955

	1913	1928	1932	1937	1940	1945	1950	1955
	INDEX (1913 = 100)							
Soviet weights								
1. 1928 weights	100	103	133	240	261	148	359	598
2. 1955 weights	100	102	132	220	238	143	317	501
U.S. weights								
3. 1914 weights	100	107	130	228	246	137	329	536
4. 1929 weights	100	105	131	214	229	126	296	480
5. 1939 weights	100	104	130	224	240	134	315	508
6. 1954 weights	100	104	136	230	246	138	323	519
			RATIO					
3 to 1	1.00	1.03	0.98	0.95	0.94	0.93	0.92	0.90
3 to 2	1.00	1.05	0.99	1.03	1.03	0.96	1.04	1.07
4 to 1	1.00	1.01	0.98	0.89	0.88	0.85	0.83	0.80
4 to 2	1.00	1.03	0.99	0.97	0.97	0.88	0.94	0.96
5 to 1	1.00	1.01	0.98	0.93	0.92	0.90	0.88	0.85
5 to 2	1.00	1.02	0.99	1.02	1.01	0.94	0.99	1.01
6 to 1	1.00	1.00	1.03	0.96	0.94	0.93	0.90	0.87
6 to 2	1.00	1.02	1.03	1.05	1.03	0.97	1.02	1.04

SOURCE: Appendix D. All indexes adjusted to cover the same forty-nine products (see text).

The index with 1914 U.S. weights shows a faster growth over the period 1913–1955 than any other index with U.S. weights. With this exception, however, growth rises uniformly as the weights are moved forward from 1929 to 1955. This behavior does not accord with the general rule already suggested that early-year weights lead to a more rapid growth in indexes than late-year weights. What is the reason for this paradox? One might conjecture that the structure of growth in productivity and output has been significantly different in U.S. and Soviet industry. That is to say, it may be that the products with the greatest decline in opportunity cost in the United States have tended to have the slowest growth in output—and probably the smallest decline in opportunity cost—in the Soviet Union. Such reasoning must remain conjectural until considerably more data are available on the Soviet economy, its growth, and the "rationality" of its price system.[24]

[24] On the last matter, see the interesting discussion by P. J. D. Wiles cited in foonote 16 above. See also Joan Robinson, "Mr. Wiles' Rationality"; D. R. Hodgman, "Measuring Soviet Industrial Expansion: A Reply," *Soviet Studies*, July 1956, 34–45;

The indexes with U.S. weights show production in 1955 as ranging from 480 to 536 per cent of production in 1913. These more or less bracket the 501 per cent shown by the index with 1955 Soviet weights, but even the upper limit falls substantially short of the 598 per cent shown by the index with 1928 Soviet weights.

Details on Product Coverage

FIXED AND VARYING COVERAGE

One important practical problem in constructing production indexes is to provide coverage for the new products continually being introduced into the economy. These new products often grow at a faster percentage rate than many older ones, for reasons discussed in the preceding chapter. Other relevant things being the same, a production index whose product coverage continually expands will tend to show a more rapid rate of growth than one whose coverage is fixed. However, in designing an index with expanding coverage, we necessarily create offsetting behavior.

If new products are to be brought into an index, either late-year weights or a system of moving weights must be used. Early-year weights obviously cannot be used for products not produced in that early year—though the official Soviet index of industrial production has done just that in a way we shall describe later. As we have already noted, a production index based on late-year or moving weights will generally show a slower rate of growth than one with the same product coverage based on early-year weights.

Are we then faced with a dilemma of choosing between two evils? In effect we are not, because a moving-weight index is usually preferred for quite independent reasons. Hence, the only significant issue is whether a fixed or a varying product coverage is to be used. A varying coverage will surely be preferred, provided that the index continues to cover a representative sample of old as well as new industries.

In the case of our indexes for industrial materials, the product coverage is the same for the two variants based on 1928 and 1955 weights, but it is higher for both of these than for the one based on 1913 weights—fifty-four products compared with forty-nine (see Table 22). The five products missing in the latter are hydroelectric power, natural gas, oil shale, magnesite metallurgical powder, and asbestos shingles—all essentially

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D. Granick, "Are Adjusted Rubles Rational? A Comment," *Soviet Studies*, July 1956, 46–49; and P. J. D. Wiles, "A Rejoinder To All and Sundry," *Soviet Studies*, October 1956, 134–143.

TABLE 22

PRODUCT COVERAGE OF INDEXES OF SOVIET INDUSTRIAL PRODUCTION

	Number of Products			
	Total	Intermediate Industrial Products	Agricultural and Transportation Equipment	Consumer Goods
Industrial materials				
1913 weights	49	32	0	17
1928 weights	54	37	0	17
1955 weights	54	37	0	17
U.S. weights	50[a]	33	0	17[a]
Finished civilian products				
1928 weights	73	13	27[b]	33
1955 weights	87	16	35[c]	36[d]
All civilian products				
1928 weights	101	43	23	35
1955 weights	119	46	35[c]	38[d]

SOURCE: Table D-10.

[a] The index with 1929 weights does not include beer, and hence covers only sixteen consumer goods and forty-nine products in all.

[b] Includes four series with data missing for one or more benchmark years. For computational convenience, these were not included in the index for all industrial products. They are all of minor importance.

[c] Includes three series with data missing for one or more benchmark years.

[d] Includes two series with data missing for one or more benchmark years.

TABLE 23

EFFECT OF PRODUCT COVERAGE ON PRODUCTION INDEX FOR SOVIET INDUSTRIAL MATERIALS

	INDEX, 1913 = 100			
	Forty-Nine Products		*Fifty-Four Products*	Ratio
	1913 Weights (1)	1928 Weights (2)	1928 Weights (3)	(3)/(2)
1913	100	100	100	1.00
1928	103	100	100	1.01
1932	141	135	131	0.97
1937	249	222	229	1.03
1940	276	245	254	1.04
1945	161	139	148	1.06
1950	364	318	338	1.06
1955	588	513	550	1.07

SOURCE: Tables D-1 and D-10.

new products in the Soviet Union. If these same products are excluded from the index with 1928 weights, it shows a significantly slower rate of growth over most of the Soviet period than the index with full product coverage (see Table 23). We did not deliberately use the same product

coverage for indexes with 1928 and 1955 weights; the available data simply do not permit a meaningful expansion of coverage, probably for the reason to be discussed in the third paragraph below.

In the case of our indexes for finished civilian materials, the one with 1955 weights covers eighty-seven products, while the one with 1928 weights covers only seventy-three. The products included in the former but not in the latter are three types of metallurgical bricks, nine items of agricultural equipment, two items of apparel, and one item of consumer durables. These are virtually all products not produced in quantity in 1928. The index with 1928 weights includes one item of agricultural equipment (combined plows and drills) not included in the index with 1955 weights, because no 1955 price could be found.

Finally, our index for all civilian products with 1955 weights covers 119 products, while the one with 1928 weights covers 101. The products included in the former but not in the latter are those given above plus one type of fuel (oil shale) and three items of transportation and agricultural equipment with incomplete data. Because appropriate prices could not be found, synthetic dyes and ginned cotton were included in the index with 1928 weights but not in the one with 1955 weights.

The differences in coverage just summarized actually understate considerably the extent to which new products and improvements in quality have been incorporated into our indexes. The Soviet practice of expressing output in "conventional units" amounts to adjusting the basic series of physical output to reflect introduction of new products and improvements in quality. Thus, if a new kind of window glass is produced, it is translated into "conventional" square meters on the basis of a coefficient (weight factor) that is designed to reflect its qualitative as well as physical characteristics. Other examples are given in Chapter 2. It is even quite possible, though no specific evidence has been found, that the component items in a heterogeneous series like window glass, paper, cement, canned goods, and so on are weighted together by their prices to form the published series on physical output. There is no doubt in some cases that complicated weight factors are used; the only question is whether they reflect opportunity cost or something else. In any event, many of the "basic" series used in our indexes are undoubtedly weighted subindexes reflecting introduction of new products and improvements in quality.

NARROW AND BROAD SCOPE OF INDEXES

Each of our three types of index represents a different scope of industrial activity, and it is plain from Table 24 and Chart 12 that measured growth

TABLE 24

COMPARISON OF MOVING-WEIGHT INDEXES OF INDUSTRIAL PRODUCTION WITH DIFFERING SCOPE: SOVIET UNION, BENCHMARK YEARS, 1913–1955

	All Civilian Products (1)	Industrial Materials (2)	Finished Civilian Products (3)	*Ratio* (1)/(2)	*Ratio* (1)/(3)
	INDEX (1913 = 100)				
1913	100	100	100	1.00	1.00
1928	102	102	99	1.00	1.03
1932	144	133	126	1.08	1.14
1937	268	233	239	1.15	1.12
1940	274	257	226	1.07	1.07
1945	123	157	100	0.78	1.23
1950	397	331	295	1.20	1.35
1955	577	511	460	1.13	1.25
	LINK RELATIVE (INITIAL YEAR OF PERIOD = 100)				
1913–1928	102	102	99	1.00	1.03
1928–1932	140	131	128	1.08	1.09
1932–1937	186	175	189	1.06	0.98
1937–1940	102	110	94	0.93	1.09
1940–1945	45	61	44	0.73	1.02
1945–1950	323	210	295	1.54	1.09
1950–1955	145	154	156	0.94	0.93

SOURCE: Table 16.

varies with the scope of the index. Over the period 1913–1955, the index for all civilian products registers a growth 13 per cent faster than the index for industrial materials, and a growth 25 per cent faster than the index for finished civilian products. Over shorter periods, the relations are more complex, in particular because the effects of industrial mobilization and demobilization are reflected differently in the different indexes, for reasons to be explored in the section after next.

The same kind of differential behavior is shown in part by production indexes for U.S. industry (Table 25). Over the period 1913–1955, our index for all products shows a measured growth 19 per cent faster than an index for industrial materials. It is interesting that this divergence is registered in two periods, 1913–1929 and 1939–1947, both of which include a major war. A similar comparison cannot be made with an index for finished products, because such an index is not available for years before 1939. Over the period 1939–1955, the extended Federal Reserve Board index for finished products shows a somewhat more rapid

TABLE 25

COMPARISON OF MOVING-WEIGHT INDEXES OF INDUSTRIAL PRODUCTION WITH DIFFERING SCOPE: UNITED STATES, BENCHMARK YEARS, 1913–1955

	All Products[a] (1)	Industrial Materials[b] (2)	All Products[a] (3)	Industrial Materials[b] (4)	Finished Products[c] (5)	*Ratio* (1)/(2)	(3)/(4)	(3)/(5)
	INDEX (1913 = 100)		INDEX (1939 = 100)					
1913	100	100				1.00		
1929	188	165				1.14		
1932	100	99				1.01		
1939	188	166	100	100	100	1.13	1.00	1.00
1947	321	269	171	162	182	1.19	1.06	0.94
1950	366	307	195	185	206	1.19	1.05	0.96
1955	473	396	252	238	265	1.19	1.06	0.95
	LINK RELATIVE (INITIAL YEAR OF PERIOD = 100)							
1913–1929	188	165				1.14		
1929–1932	53	60				0.88		
1932–1939	188	168				1.12		
1939–1947	171	162	171	162	182	1.06	1.06	0.94
1947–1950	114	114	114	114	113	1.00	1.00	1.01
1950–1955	129	129	129	129	129	1.00	1.00	1.00

[a] Table A-32.

[b] 1913–1939, Moore's index as revised by Greenslade and Wallace (R. V. Greenslade and Phyllis A. Wallace, "Industrial Growth in the Soviet Union: Comment," *American Economic Review*, September 1959, p. 689); 1939–1947, an index similar in construction to the link for 1947–1955; 1947–1955, Federal Reserve Board index (*Federal Reserve Bulletin*, December 1959, p. 1469).

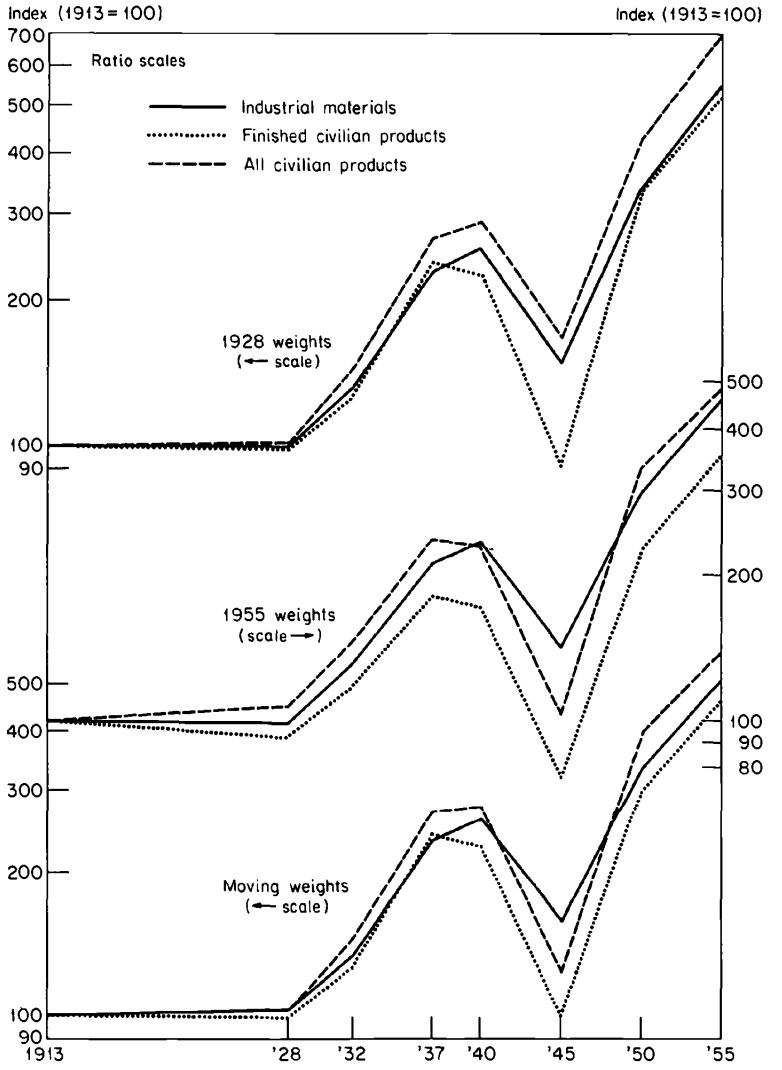
[c] 1939–1947, an index similar in construction to the link for 1947–1955; 1947–1955, *ibid.*

rise than the FRB index for all products, the divergence being concentrated, once again, in the period 1939–1947.

In interpreting these comparisons, one must keep in mind that there are some important differences between the Soviet and U.S. counterpart indexes, the most important being that the U.S. index for all products directly covers military products over the years since 1939, while the Soviet index for all civilian products does not. As we shall see below, when the Soviet index is adjusted to reflect estimated output of military products, the long-run divergence of the index for all products from the one for industrial materials becomes remarkably similar for the two countries: 19 per cent for the United States compared with 21 per cent for the Soviet Union over the period 1913–1955.

Another difference is that the Soviet index for industrial materials is based on a fixed sample of products while the U.S. counterpart is not, the product coverage varying over the three links in the index. This

CHART 12
Indexes of Soviet Industrial Production, Grouped by Weighting System, Benchmark Years, 1913–1955



Source: Table 16.

difference is, however, not as important as it might seem since, as we noted earlier, new products and improvements in quality are reflected in the product coverage of our Soviet index by virtue of the Soviet practice of expressing output in conventional units. Moreover, the products in the

index account for almost all Soviet materials on which output data have been published for as late as 1955. It is doubtful that many materials of significance in recent times have been omitted.[25]

One should be careful not to leap to the conclusion that any one of our Soviet indexes is inherently a better indicator of Soviet industrial growth than the others. All may either overstate or understate the areas of growth they purport to measure. It is worth noting that, if the basic data on physical output for 1955 were exaggerated by as much as 13 per cent relative to 1913, the index for industrial materials might be more accurate as a measure of over-all industrial growth than the one for all civilian products.

MACHINERY AND EQUIPMENT

Some of the most serious practical difficulties in constructing production indexes arise in the case of durable commodities, particularly capital equipment and military end items. It is virtually impossible to identify meaningful homogeneous categories for some of these items, because so many widely differing varieties are produced, often custom built, and because basic designs change so swiftly and radically. Whenever such heterogeneous categories of products are included in Western production indexes, they are often represented indirectly by input series—most frequently, man-hours of employment—or by an appropriate value of production deflated by some price index drawn from another sector of industry.

For the United States, the most comprehensive production indexes covering the growth of manufacturing up to World War II are those of Professors Edwin Frickey and Solomon Fabricant.[26] Frickey's index, which covers the period 1860–1914, includes only four items of durable goods, all in the category of transportation equipment: railroad freight cars, railroad passenger cars, automobiles, and vessels. Fabricant's index, which covers the period 1899–1937, also includes only transportation equipment, though in much greater detail: fifty-nine items are included in all, but some cover only short spans of time.[27]

[25] For an apparently contrary view on the comparability of U.S. and Soviet indexes for industrial materials, see Greenslade and Wallace, "Industrial Growth in the Soviet Union." Their argument is commented on in my "Reply," *American Economic Review*, September 1959, especially p. 699.

[26] Edwin Frickey, *Production in the United States, 1860–1914*, Cambridge, Mass., 1947; and Fabricant, *Manufacturing Industries*.

[27] Fabricant also constructed indexes for agricultural implements, phonographs, radios, refrigerators, scales and balances, sewing machines, typewriters, and washing and ironing machines (see Fabricant, *Manufacturing Industries*, pp. 287 ff). All but one (phonographs) begins with 1921 or later, and none is included in the aggregate index for

Fabricant summarized the problems of measurement in the following words:[28]

> The task of measuring the physical output of machinery is complicated by two serious difficulties. In the first place, few of the machinery industries are covered by adequate quantity data on output; and in the second place, the available statistics are ambiguous because the products are not divided into homogeneous subclasses. Inadequacy of data and of subclassification are almost inevitable when the variety of items produced is as wide as it is in the case of machinery, and no classification, no matter how detailed, could be expected to resolve the problem conclusively. The enormous variety of machines illustrates rather pointedly the extent to which our industrial processes are both specialized and mechanized. The continuing improvements in our productive equipment, tools and machines, reflect the drive toward faster, better, cheaper production—a basic factor in our economic progress. In other words, some of the very factors that have made this a machine era also make it impossible for us to measure in a straightforward manner the degree to which the physical volume of output of machines has risen, and the size of the existing stock of mechanical instruments.

The Federal Reserve Board annual index of industrial production in the United States also did not include the more heterogeneous categories of durable goods as it was constructed up to 1940. In that year the coverage of the annual index was expanded to include many of these categories back through 1923, and in 1941 and 1942 it was further expanded to include wartime armaments.[29] Output of these products was measured primarily by man-hours of employed labor adjusted for presumed changes (improvements) in productivity that were estimated by a variety of devices, almost all of which relied on data for other sectors of industry. In the monthly index, the man-hour series accounted for about 33 per cent of the aggregate value of the index in 1935–1939 and for about

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manufacturing. We have included some of these items, along with others he did not cover, in our index for consumer durables, which is covered by our aggregate index for Soviet industry.

[28] *Ibid.*

[29] *Federal Reserve Bulletin*, August 1940, 753–771; *ibid.*, September 1941, 878–881; and *ibid.*, October 1943, 940–952. It is interesting that the FRB index for manufacturing, as revised in 1940, shows a slower growth over 1923–1939 than Fabricant's index, despite the fact that the former has a broader coverage of machinery than the latter (see *Historical Statistics of the United States, 1789–1945*, Washington, 1949, series J-15 and J-30).

58 per cent in 1943.[30] The resulting index has been criticized, particularly for its measurement of production in wartime.[31]

The FRB index was thoroughly revised in 1953, the reliance on man-hour series being greatly reduced: those used as sole indicators of output in the annual index accounted for 4 per cent of all weights in this revised index and those used along with other information of various types accounted for an additional 13 per cent.[32] Except for a few miscellaneous products of minor importance in other sectors, these series are concentrated in the industrial groups of machinery, transportation equipment, and instruments and related products—which, taken together, also include the bulk of military products. Series in these groups whose output is measured entirely or partially by man-hours account for around 13 per cent of all weights, or more than half the full weight accorded to all series in these groups. In the heterogeneous categories not represented by man-hour series, output is generally broken down in considerable detail: 199 series of farm machinery; 71 series of machine tools; 62 series of commercial refrigeration equipment; 8 series of electric lamps; and so on.[33]

The difficulties in measuring output of heterogeneous machinery may be illustrated by data on machine tools for the United States taken from the *Census of Manufactures* for 1939, 1947, and 1954 (see Table 26). The first problem is to define the boundaries of the industry and to gather comparable data for various years. It is plain even from our simplified presentation that this problem alone is almost without solution, and in this case for a country that publishes voluminous and finely detailed information.

The second problem is to choose an indicator of production. Numbers of tools are not meaningful since by reasonable variations in definition the number can vary enormously: from 190 thousand to 2.4 million in 1947, not taking account of metalworking machinery related to machine tools in their strictest meaning. This should, incidentally, serve as a warning against comparing Soviet and U.S. production of machine tools

[30] Moore, *Production of Industrial Materials*, p. 5, and *Federal Reserve Bulletin*, October 1943, p. 949.

[31] See Moore, *Production of Industrial Materials*, particularly pp. 42 ff. For a defense of the FRB index of wartime production, see Frank R. Garfield, "Measurement of Industrial Production since 1939," *Journal of the American Statistical Association*, December 1944, 439–454.

[32] *Federal Reserve Bulletin*, December 1953, p. 1258. In the monthly index, man-hour series accounted for 45 per cent of the total weights in 1947 (*ibid.*). All further data in this paragraph are taken from *ibid.*, pp. 1239–1291.

[33] The FRB index was further revised as of December 1959, apparently with additional improvement in the handling of man-hour series. The details of this revision are not available at the time of this writing.

TABLE 26

DATA ON PRODUCTION OF METALWORKING MACHINE TOOLS:[a] UNITED STATES, 1939, 1947, AND 1954

	Physical Output (thousand units)			*Value of Output (million dollars)*			*Percentage of Value Covered by Physical Output*		
	1939	1947	1954	1939	1947	1954	1939	1947	1954
Industrial tools									
Boring	1.5	1.4	3.2	14.2	25.8	114.4	100	100	99
Drilling	3.2	21.1	15.2	12.4	33.5	86.1	82	98	99
Gear-cutting	1.7	1.7	2.5	11.2	17.7	48.1	100	100	97
Grinding and polishing	7.6	85.6	53.6	32.4	56.4	154.4	80	78	94
Lathes	27.3	36.2	21.0	49.8	92.9	206.9	95	99	100
Milling	0.3	7.5	11.5	24.2	35.3	121.5	13	100	99
Others[b]	4.1	37.4	16.8	32.6	450.7	780.0	19	14	4
Total, coverage A	[c]	191.0	123.8	[c]	712.4	1,511.4	[c]	40	50
Nonindustrial tools[d]	[c]	692.6	n.a.	[c]	30.9	9.3	[c]	86	0
Total, coverage B	45.8	883.5	n.a.	176.8	743.2	1,520.7	67	42	49
Power-driven hand tools[e]	n.a.	1,533.8	2,462.3	n.a.	112.2	170.5	n.a.	52	50
Total, coverage C	n.a.	2,417.4	n.a.	n.a.	855.4	1,691.2	n.a.	43	49

Detail and sums may not be consistent because of rounding.

SOURCE: *Census of United States Manufactures* for 1939, 1947, and 1954.

[a] Machine tools are defined according to the Standard Industrial Classification as power-driven tools that shape metal by grinding or progressively cutting away chips. They do not include machinery for shaping, pressing, forging, or bending metal, where the shaping action is not dependent on cutting or grinding away chips.

[b] Includes the following tools: broaching, planing, shaping, centering, cutting-off, keyseating, pipecutting and pipethreading, slotting, other threading and tapping, and otherwise unspecified. Also includes (in value of output) spare parts, rebuilt tools, and attachments and accessories for metalworking tools.

[c] Most nonindustrial tools are included with industrial tools, distributed by type.

[d] Tools for home workshops, laboratories, garages, service stations, etc.

[e] Both electric and pneumatic.

TABLE 27

COMPARISON OF PRODUCTION INDEXES FOR MACHINE TOOLS AND RELATED PRODUCTS: UNITED STATES, 1939, 1947, AND 1954

Type of Index	*Link Relatives (Initial Year = 100)* 1939–1947	1947–1954
Machine tools		
Unweighted number of tools[a]		
Coverage A	417[b]	65
Coverage B	1,929	n.a.
Deflated value of output[a]		
Coverage A	283[b]	149
Coverage B	295	144
Coverage C	n.a.	139
Federal Reserve Board index[c]		
Coverage A	141	n.a.
All metalworking machinery		
Deflated value of output[d]	n.a.	119
Federal Reserve Board index[e]	n.a.	139

[a] Based on data in Table 26. Value deflated by price index for metalworking machinery (*Survey of Current Business*, November 1953, pp. 18 f) extrapolated from 1952 through 1954 by BLS price index for same industrial category (*Statistical Abstract of the United States, 1956*, p. 322). Price index for 1947 is 142.5 per cent of 1939; for 1954, 142.3 per cent of 1947.

[b] For 1939, nonindustrial machine tools are assumed to be of negligible significance in number and value.

[c] *Census of U.S. Manufactures: 1947, Indexes of Production*, p. 21. Index with 1939 and 1947 cross weights.

[d] Coverage C from Table 26, plus value of output of metalworking machinery except machine tools, which was as follows (million dollars): 616.1 for 1939 and 793.9 for 1954. The latter data are taken from the 1954 *Census of Manufactures*. Deflated by price index given in note *a* above.

[e] *Federal Reserve Bulletin*, December 1953, p. 1306, and July 1956, p. 751.

in terms of numbers produced. (The basic Soviet data are given in numbers.) In any event, we note the great discrepancies among a few alternative production indexes presented in Table 27.[34] It is perhaps most interesting that, under the most restricted definition of machine tools (coverage A), the index from number of tools is higher than both the weighted output and deflated value indexes for 1939–1947, but it is lower than the deflated value index for 1947–1954; in fact, the index from numbers shows a decline of 35 per cent in the latter period, while the index from deflated value shows an increase of 49 per cent.

Such difficulties of measurement make any production index for heterogeneous machinery largely arbitrary and generally unreliable, sometimes in direction of movement as well as magnitude. This is

[34] Other illustrations of conflicting indexes of machinery output with varying coverage are given by Gerschenkron, *Soviet Machinery Output*, pp. 34 ff.

particularly true for the Soviet Union, where statistics on output and value do not approach the detail available for the United States. We have, nevertheless, constructed illustrative indexes for miscellaneous machinery, primarily to indicate how much difference there might be in our indexes if these items were included. The series covered by these indexes are shown in Table D-10 of Appendix D; they have been weighted by Soviet prices for 1928 and 1955, as given in Table D-9.[35]

The moving-weight index for machinery and equipment including miscellaneous items rises about 20 per cent more rapidly over the entire Soviet period than the one excluding miscellaneous items; it also rises more rapidly over all subperiods except 1932–1937 and 1945–1950 (see Table 28). For all civilian products, the index including miscellaneous machinery rises about 7 per cent more rapidly over the entire Soviet period than the one excluding it. Most of this discrepancy is introduced during the period 1945–1950, when paradoxically the index for machinery

TABLE 28

MOVING-WEIGHT PRODUCTION INDEXES FOR CIVILIAN INDUSTRIAL PRODUCTS WITH DIFFERING PRODUCT COVERAGE FOR MACHINERY AND EQUIPMENT: SOVIET UNION, BENCHMARK YEARS, 1913–1955

	Machinery and Equipment		*All Civilian Products*	
	Excl. Misc. Machinery	Incl. Misc. Machinery	Excl. Misc. Machinery	Incl. Misc. Machinery
	INDEX (1913 = 100)			
1913	100	100	100	100
1928	143	149	102	103
1932	426	544	144	147
1937	1,624	1,595	268	273
1940	1,140	1,215	274	280
1945	265	380	123	127
1950	2,637	2,900	397	423
1955	2,994	3,627	577	619
	LINK RELATIVE (INITIAL YEAR OF PERIOD = 100)			
1913–1928	142	149	102	103
1928–1932	299	365	140	143
1932–1937	381	293	186	185
1937–1940	70	76	102	103
1940–1945	23	31	45	45
1945–1950	993	763	323	333
1950–1955	114	125	145	146

SOURCE: Tables 16, D-3, and D-4.

[35] To illustrate the problems of measuring output of machinery and equipment, we also constructed twelve different indexes with 1928 weights, varying in coverage and weighting system. These are set forth in Table A-8 and discussed in the surrounding text of Appendix A. We consider here only the moving-weight indexes for machinery and equipment (excluding consumer durables), based in part on 1928 direct value-added weights.

and equipment including miscellaneous items rose less rapidly than the one excluding them. Hence, most of the discrepancy is attributable to the fact that, by including miscellaneous machinery, the increased weight given to the machinery sector during 1945–1950 more than offset the decreased growth of that sector, as far as the net effect on the over-all production index is concerned.

For the period 1928–1937, our indexes for machinery and equipment, when adjusted to cover consumer durables, may be compared with those constructed by two other Western scholars, Alexander Gerschenkron and Donald Hodgman (see Table 29 and Chart 13).[36] Gerschenkron's index is weighted with 1939 prices drawn from U.S. industry, after a painstaking effort to match Soviet and U.S. counterparts in consultation with U.S. manufacturers who had engaged in commercial dealings with the Soviet Union. In Hodgman's index, product groups are weighted by adjusted Soviet wage-bill data for 1934, and individual products within groups are weighted by unit values taken from several U.S. censuses of manufactures. In coverage, these two indexes most closely resemble our index including miscellaneous machinery and consumer durables, although, because of the greater detail in weights, they both utilize a more detailed breakdown of products than ours.

Gerschenkron's index rises less rapidly than Hodgman's, and both rise less rapidly than either of ours based on 1928 Soviet weights, which are also the weights we use for our moving-weight indexes over this period. On the other hand, both Gerschenkron's and Hodgman's indexes rise more rapidly than either of ours based on 1955 Soviet weights. In other words, our indexes based on 1928 and 1955 weights bracket theirs based on more or less "intermediate" weights from the point of view of industrialization, a result we should normally expect. However, the discrepancies are very large for such a short span of time: our highest index for 1937 exceeds Gerschenkron's by 130 per cent and Hodgman's by 94 per cent; our lowest falls short of Gerschenkron's by 25 per cent and Hodgman's by 37 per cent. Under these circumstances, it is hardly meaningful to look for a "correct" production index for machinery.

Similar conclusions emerge from comparisons over a longer period of time with two indexes recently constructed by Demitri Shimkin and Frederick Leedy and by Norman Kaplan and Richard Moorsteen (see Table 29 and Chart 13). The full details underlying these indexes have not yet become available to us, but from the general description they

[36] Gerschenkron, *Soviet Machinery Output*, and Donald Hodgman, *Soviet Industrial Production, 1928–1951*, Cambridge, Mass., 1954, pp. 107 and 158 ff.

TABLE 29

COMPARISON OF NBER AND OTHER WESTERN PRODUCTION INDEXES FOR CIVILIAN MACHINERY AND EQUIPMENT: SOVIET UNION, BENCHMARK YEARS, 1928–1955

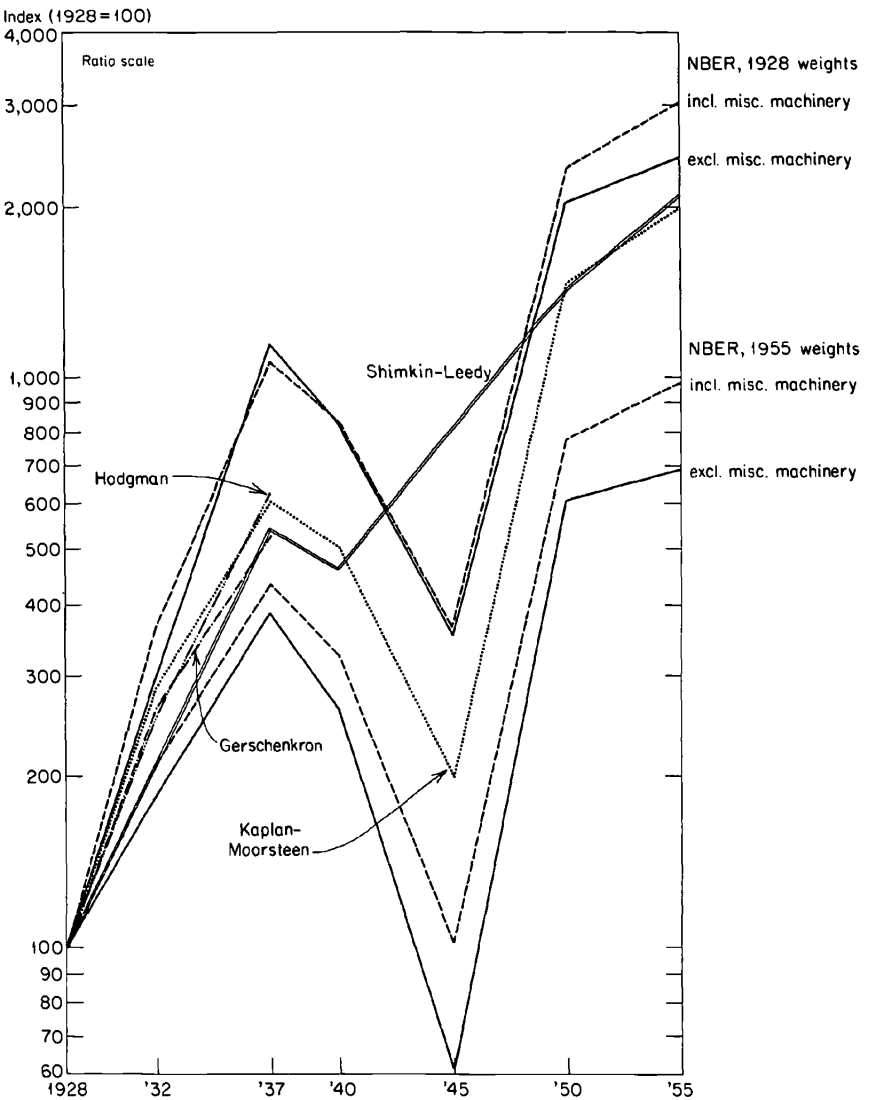
					NBER			
					Excl. Misc. Mach.		*Incl. Misc. Mach.*	
	Gerschenkron	Hodgman	Shimkin-Leedy	Kaplan-Moorsteen	1928 Weights	1955 Weights	1928 Weights	1955 Weights
				INDEX (1928 = 100)				
1928	100	100	100	100	100	100	100	100
1932	264	258		287	299[a]	185[a]	364[a]	212[a]
1937	525	626	540	601	1,139[a]	386[a]	1,067[a]	436[a]
1940			460	504	826	262	828	326
1945				200	351	61	362	102
1950			1,430	1,470	2,025	607	2,316	779
1955			2,100	2,000	2,438	689	3,021	974
				LINK RELATIVE (INITIAL YEAR OF PERIOD = 100)				
1928–1932	264	258		287	299[b]	185[b]	364[b]	212[b]
1932–1937	199	243		210	381[b]	209[b]	293[b]	206[b]
1937–1940			84	84	73	68	78	75
1940–1945				40	42	23	44	31
1945–1950				735	577	994	640	764
1940–1950			313	292	245	232	280	239
1950–1955			147	136	120	114	130	125

SOURCE: Gerschenkron: *Soviet Machinery Output*, p. 25. Includes consumer durables. Hodgman: *Soviet Industrial Production*, p. 107. Includes consumer durables. Kaplan-Moorsteen: Norman M. Kaplan and Richard Moorsteen, "Indexes of Soviet Industrial Output" (mimeographed), II, RAND Corporation, RM-2495, Santa Monica, 1960, p. 237. Shimkin-Leedy: *Ibid.*, as derived from data in Demitri B. Shimkin and Frederick A. Leedy, "Soviet Industrial Growth—Its Cost, Extent and Prospects," *Automotive Industries*, January 1, 1958, p. 7. NBER: Tables D-3 and D-4.

[a] If consumer durables are included to make the indexes comparable with those of Hodgman and Gerschenkron, the values are as follows (see Table A-15): col. 5, 307 and 1205; col. 6, 189 and 394; col. 7, 368 and 1121; and col. 8, 214 and 440.

[b] Including consumer durables (see note *a* above), the values are as follows: col. 5, 307 and 393; col. 6, 189 and 208; col. 7, 368 and 305; and col. 8, 214 and 206.

CHART 13
NBER and Other Western Production Indexes for Civilian Machinery and Equipment: Soviet Union, Benchmark Years, 1928–1955



Source: Table 29.

seem to have about the same product coverage as our indexes including miscellaneous machinery, though the breakdown of products seems to be more detailed than ours. The Shimkin-Leedy index is based on 1934 Soviet weights; the Kaplan-Moorsteen index, on 1950 Soviet weights. As would be expected from the fact that their weight bases lie within ours, our indexes bracket theirs over the period as a whole, though not within all subperiods. Two striking cases where this is not so are the periods 1940–1950 and 1950–1955, over which our indexes all rise more slowly than theirs. Moreover, their indexes parallel each other more closely than would probably be predicted from the differences in the weight bases. These irregularities may be due in part to the peculiarities of the Soviet price structure in both 1934 and 1950, as we note in technical note 4 of Appendix A. But a more satisfactory explanation must wait until the details of their two indexes are published.

MILITARY PRODUCTS

The problem of measuring output of military products becomes acute for periods of rapid armament or disarmament surrounding wars. If it were not for war preparations, it would matter little whether munitions were covered or not, since production indexes would not be affected much either way. Hence a dilemma arises because the kind of measurement most needed is the hardest to make.

One can scarcely conceive of industrial production as a continuum running from peacetime through wartime. To restate a question posed earlier: how can we measure how much the caterpillar grows when it turns into a butterfly? In recognition of this problem, the peacetime index of industrial production was suspended in the United Kingdom during World War II; and, though continued in the United States, the resulting attempts to measure output of munitions by labor input have been, as we noted above, widely criticized as misrepresenting actual production.

Geoffrey Moore summed up the matter with reference to American experience:[37]

> Under these circumstances [of a transition from peace to war] it seems best to abandon any attempt to measure total industrial production, for the fact of conversion lends an element of arbitrariness, unreality, and uncertainty to any index that purports to measure the total. There is arbitrariness in the choice of weight factors used to

[37] Moore, *Production of Industrial Materials*, p. 49.

combine discontinuous series; there is unreality in the idea of comparing aggregates that, to a large extent, consist of commodities not common to both peace and war periods; there is uncertainty because widely different results can be obtained by different methods of selecting (a) the weight factors mentioned above, and (b) the series that are to be included. We do not believe these difficulties attach, to nearly the same extent, to an index of industrial materials production. This does not mean that such an index measures total output; but it does measure a part that it is feasible to measure, a part that is of interest *per se*, and a part that does influence the aggregate amount of commodities produced in both peacetime and wartime.

These comments apply to a situation in which data are relatively bountiful. By contrast, data on Soviet mobilization are almost entirely lacking: Grossman speaks revealingly of "the shroud that fell on Soviet economic statistics in the late thirties."[38] That shroud has not yet been lifted as far as military production is concerned, for either the interwar or postwar period. Consequently, few Western scholars have been bold enough to try to estimate military production, and those who have—we show their efforts below—have limited themselves to admittedly rough guesses.

From the strict, scholarly point of view, it would be best to admit the impossibility of accurately measuring military production and restrict indexes to what can be reasonably measured, warning of the limited coverage and permitting anybody to make such adjustments as he wishes. We would have preferred to do this, had it not been for the strong objections raised in authoritative quarters to the effect that inclusion of military production would significantly raise the growth rates we had found for the period 1937–1955, and particularly for 1950–1955.[39] Unfortunately, the objections have not been accompanied by the data needed to do the job, so that we have been forced to make our own estimates without help from the critics. We now present them for what they may be worth (Table 30).

Our estimates are discussed in some detail in technical note 3 of Appendix A, and it will be enough to give a brief summary here. The index for military products is derived from estimated value of output deflated

[38] G. Grossman, "Steel, Planning, and War Preparedness in the USSR," *Explorations in Entrepreneurial History*, Vol. IX, No. 4, p. 231.

[39] See, for example, Allen Dulles's testimony in *Hearings, November 13–20, 1959*, Joint Economic Committee, Congress of the United States, Washington, 1960, pp. 1 ff, especially p. 5; and Greenslade and Wallace, "Industrial Growth in the Soviet Union," especially p. 694.

TABLE 30

PRODUCTION INDEXES ADJUSTED FOR ESTIMATED MILITARY PRODUCTION: SOVIET UNION, BENCHMARK YEARS, 1913–1955

	Military Products	*All Products*		Industrial Materials	*All Products*		Industrial Materials
		Civilian	Total		Civilian	Total	
		INDEX (1937 = 100)			INDEX (1913 = 100)		
1913		37	35	43	100	100	100
1928		38	36	44	102	102	102
1933	4	57	54	60	152	153	140
1937	100	100	100	100	268	285	233
1940	220	102	112	110	274	318	257
1945	627	46	93	67	123	264	157
1946	92	60	63	76	160	180	178
1950	103	148	138	142	397	393	331
1955	288	215	218	219	577	620	511
	LINK RELATIVE (INITIAL YEAR OF PERIOD = 100)						
1913–1928		102	102	102			
1928–1933		149	149	137			
1933–1937	2,500	176	186	166			
1937–1940	220	102	112	110			
1940–1945	285	45	83	61			
1940–1946	42	59	56	69			
1945–1950	16	323	149	210			
1946–1950	112	247	219	187			
1950–1955	282	145	158	154			

SOURCE: Tables A-10, A-11, and 16. Some data for 1933 are from Appendix D.

by a price index for basic industrial products. The value data are essentially direct estimates through 1948; for later years, they are derived residually, as the difference between earmarked defense expenditures and estimated maintenance and operational costs of the armed forces. The latter were calculated before Khrushchev revealed definite information on the changing size of the armed forces in the postwar period,[40] and hence they are probably too low around 1950 and too high around 1955. Consequently, the index of military production probably shows, on this account, too rapid a rise over the period 1950–1955; covered military production in 1955 may, in fact, be as much as 25 per cent lower than shown.[41] On the other hand, atomic energy is not directly covered by our estimates, and this may be expected to balance against the overstatement of 1955 production of conventional military products.

[40] N. S. Khrushchev, "Report at Supreme Soviet Session," *Pravda*, January 15, 1960 (translated in *Current Digest*, XII, 2, pp. 3 ff).

[41] See the annex to technical note 3 of Appendix A.

When the index for all industrial products is adjusted to include our estimate of military production, it shows a growth more than 7 per cent faster over 1913–1955 than the index for civilian products only. Interestingly, most of the divergence takes place by 1937, with only a slight divergence since that date. Moreover, the indexes for all products and for industrial materials show a closely parallel movement since 1937, except for the year 1945. On the other hand, the index for all products shows substantially more growth over 1950–1955 than the index for all civilian products, and in this respect our critics have been right.

TABLE 31

COMPARISON OF NBER AND OTHER WESTERN ESTIMATES OF MILITARY PRODUCTION: SOVIET UNION, BENCHMARK YEARS, 1933–1955

	Hodgman[a]	M. G. Clark[b]	Shimkin-Leedy[c]	NBER[d]
1933		39		4
1934			30	
1937	100	100	100	100
1938		127		132
1940	335		128	220
1945	202			627
1950	507		100	103
1955			256	288

[a] Implicit index, derived from data in Hodgman, *Soviet Industrial Production*, pp. 86 ff.

[b] Consumption of steel by the munitions industry for fabrication. (M. Gardner Clark, *The Economics of Soviet Steel*, Cambridge, Mass., 1956. p. 316.) Clark does not offer this as an index of military production, but it has been cited elsewhere as a possible index (see, e.g., Grossman, "Steel, Planning, and War Preparedness").

[c] Shimkin and Leedy, "Soviet Industrial Growth," p. 53. Based on estimated consumption of rolled steel by military end items. Underlying data supplied in dittoed form by author.

[d] Table A-10.

Our estimate of military production is compared in Table 31 with the few available estimates of others. There is a reasonably close correspondence between the Shimkin-Leedy index and ours over the spans 1937–1950 and 1950–1955; over other shorter periods that can be compared, there is little correspondence. The Shimkin-Leedy index is estimated military consumption of rolled steel, derived residually since 1937. Our index hardly agrees at all with the implicit Hodgman index, which he describes as "painfullly rough and ready" and involving "some exceedingly cavalier estimates."[42]

[42] Hodgman, *Soviet Industrial Production*, pp. 88 and 85. We have reconstructed Hodgman's implicit index from the information he gives on how he adjusted his total index to reflect military products.

There are some interesting parallels in the behavior of production indexes for the Soviet Union and the United States when they cover estimated military production. First, as we have already noted, over 1913–1955 the divergence of the index for all products from the one for industrial materials is 19 per cent in the case of the United States and 21 per cent in the case of the Soviet Union (see Tables 25 and 30). Second, an apparently artificial peak occurs in the indexes for all products in both countries in the year of maximum military production during World War II: in 1943 for the United States and in 1945 for the Soviet Union (see Tables 30 and A-32). With reconversion, the U.S. index shows a decline of 28 per cent below this peak by 1946; the Soviet index shows a decline of 32 per cent by the same year, with the bulk of reconversion, according to our estimates, taking place in one year instead of three. Again as we have noted, it is doubtful that the wartime peaks and the consequent declines in these index numbers can be treated as at all commensurate with movements in peacetime indexes, because of the abnormal problems of measuring wartime output already described. The fact that the wartime peaks exaggerate actual expansion of productive capacity is shown by the relative behavior of indexes for all products and for industrial materials: the former shows a rise 58 per cent greater than the latter for the United States over 1939–1943 and 36 per cent greater for the Soviet Union over 1940–1945.

Comparison of Our Production Indexes with Others

THE OFFICIAL SOVIET INDEX

With a rare show of virtual unanimity in the field of Soviet studies, Western scholars have long agreed that the official Soviet index of industrial production grossly exaggerates the industrial growth that has taken place. The reasons for this exaggeration have been widely discussed,[43] and they will be reviewed only very briefly here. Unfortunately, the defects in the Soviet index cannot be carefully examined and precisely defined, because the details underlying it have never been published in such a way that independent scholars might reconstruct it. The only recourse for Western scholars seeking a more adequate index has been to construct their own indexes from such data as have been available. We

[43] Some of the Western discussion is cited in footnote 23 of Chapter 2. See also Hodgman, *Soviet Industrial Production*, pp. 1–17; A. Nove, "'1926/27' and All That," *Soviet Studies*, October 1957, 117–130; and F. Seton, "The Tempo of Soviet Industrial Expansion," *Manchester Statistical Society*, January 1957, pp. 4–10. Seton's discussion is a clear and succinct summary of the most relevant issues, and we have patterned our own very brief discussion after his.

shall examine a few of the better-known indexes later and compare them with our own.

The official Soviet index measures "gross industrial production." In principle, gross production of every industrial enterprise is calculated by multiplying the output of every product by its corresponding full transfer price (excluding turnover taxes directly levied on the product) as of a base year. Gross production for all industry is the summed gross production for all enterprises. As new products are introduced or as old ones are modified, new prices "equivalent" to those for the base year are assigned to them, and they are counted in production in the same way as other products.

We cannot flatly predict how the use of gross instead of net weights will, in and of itself, affect the behavior of a production index. Multiple weights will be assigned to some productive activities, particularly the most advanced stages of fabrication. If those activities are growing more rapidly than other underweighted activities, growth of the index will be exaggerated by normal standards. In the Soviet case, the most overweighted areas—machinery and consumer goods—have grown at countervailing rates. Hence, in the absence of experiments with relevantly constructed index numbers, we have no basis for predicting the likely effect of gross weights from this narrow point of view.

A more significant defect of gross-weighted indexes is that they are sensitive to changes in industrial organization: a drift toward greater specialization in productive processes, characterized by a movement away from vertical integration of activities within a single plant and toward multiplication of independent plants performing specialized operations, is bound to lead to a distorting inflation of gross-weighted production indexes. Any similar changes in the purely administrative structure or statistical reporting system will have the same effect. There is no doubt that sweeping changes of this nature have taken place over the Soviet period, particularly during the First and Second Five Year Plans. It is interesting that V. Starovskii, head of the Central Statistical Administration, complains of the presumed reverse effects on the production index caused by the reorganization of industrial administration in 1957.[44]

[44] V. Starovskii, "Novye zadachi sovetskoi statistiki" [New Tasks of Soviet Statistics], *Kommunist* [The Communist], 1957, No. 14, p. 67: "Under the new industrial administration, individual industrial enterprises will be integrated and concentrated. With the amalgamation of several enterprises, the gross value of output of the new enterprise will be smaller because part of it will be considered intershop turnover, although the physical volume of output will not change. Therefore, it is important to compute indexes of industrial production in such a way as to measure correctly the dynamics of physical

The early weight base used over most of the Soviet period also tends to inflate the index. Through 1950, outputs were weighted with presumed "1926/27" prices. For 1950 on, however, the index has been constructed with a moving weight base: "1952" prices for 1950–1955, and "1955" prices for 1955 and later years.

Perhaps the most serious inflation results from the practice of continuously introducing new products into the index at inflated weights. Since new products tend to grow more rapidly in output than older ones, the over-all rate of industrial growth is seriously exaggerated by this practice. Each new product is supposed to be weighted by the price that it would have had in the weight-base year, had it been produced at that time. During the interwar period, however, the weight actually used was essentially the initial unit cost of production. This weight was inflated on two counts: first, initial costs are generally abnormally high since they include developmental expenses, apply to a pilot rate of production, and do not allow for normally rapid reductions in cost attributable to learning; second, there was a steady and substantial inflation in the price level during this period. The practice of reweighting improved products also opened the way for statistical manipulations by skillful plant managers, who could make a more favorable production record by the simple device of "improving" some of their products and assigning them higher prices.[45]

Although the general price level has tended to fall since 1949, new products are still overweighted because their initial prices are adjusted upward by the same proportion as the decline in the price level since the weight-base year. The distortions in weights on this count are probably less pronounced than during the interwar period, because the weight base is moved forward periodically. Another practice recently adopted

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output and to exclude the effect of the structure of the enterprises on the total volume of production."

It is by no means clear that Starovskii's presumption of such a downward bias is justified for recent years. In any case, Academician S. G. Strumilin estimates in a recent article (in *Ocherki sotsialisticheskoi ekonomiki SSSR* [Essays on the USSR Socialist Economy], Moscow, 1959, pp. 233–242) that net production in "1926/27" rubles multiplied only about thirteen times over 1928–1955, compared with the twenty-one-fold growth shown by the official index of gross production. For 1956, Strumilin estimates that net production increased by 8.5 per cent; the official index shows 10.7 per cent.

[45] The official Soviet index apparently does not reflect the full inflation in prices. The industrial price level, adjusted to eliminate most turnover taxes, multiplied about eleven times over 1913–1955 and 5.5 times over 1928–1955 (see Table A-17). Hence the deflated official production index for 1955 would read 250 per cent of 1913 and 380 per cent of 1928 (see Table F-2). Both of these values fall below the lower limits of our indexes.

tends, however, to reinforce the distortions. The price weights now used apparently differ according to the region in which the product is produced, whereas formerly a single price was used for each product. For each enterprise, the regional prices are apparently calculated including freight to destination. Hence, production in the more remote, faster-growing regions tends to be overweighted relative to production in the more settled, slower-growing regions.

TABLE 32

COMPARISON OF NBER AND OFFICIAL SOVIET INDEXES OF INDUSTRIAL PRODUCTION: SOVIET UNION, BENCHMARK YEARS, 1913–1955

	NBER Index[a]				
	Industrial Materials	Finished Civilian Products	All Civilian Products	All Industrial Products	Official Soviet Index[b]
	INDEX (1913 = 100)				
1913	100	100	100	100	100
1928	102	99	102	102	132
1932	133	126	144	144	267
1937	233	239	268	285	588
1940	257	226	274	318	852
1945	157	100	123	264	782
1950	331	295	397	393	1,476
1955	511	460	577	620	2,729
	LINK RELATIVE (INITIAL YEAR OF PERIOD = 100)				
1913–1928	102	99	102	102	132
1928–1932	131	127	140	140	202
1932–1937	175	189	186	198	220
1937–1940	110	94	102	112	145
1940–1945	61	44	45	83	92
1945–1950	210	295	323	149	189
1950–1955	154	156	145	158	185

[a] Tables 16 and 30. Moving weights.
[b] *Promyshlennost' SSSR* [Industry of the USSR], Moscow, 1957, p. 9.

The official Soviet index is compared with our moving-weight indexes in Table 32 and Chart 14. It shows a much larger percentage increase, or smaller percentage decline, than our index for all industrial products in every subperiod. The same holds true in comparisons with our other indexes, except for the period 1945–1950. The peculiar relative behavior in that subperiod may be attributed to the fact that the official index attempts a direct coverage of armaments production while those of ours just referred to do not. The average annual rates of growth for the official index and our moving-weight index for all industrial products

CHART 14
NBER and Other Indexes of Soviet Industrial Production, Benchmark Years, 1913–1955

A. NBER and Official Soviet Indexes, 1913–1955

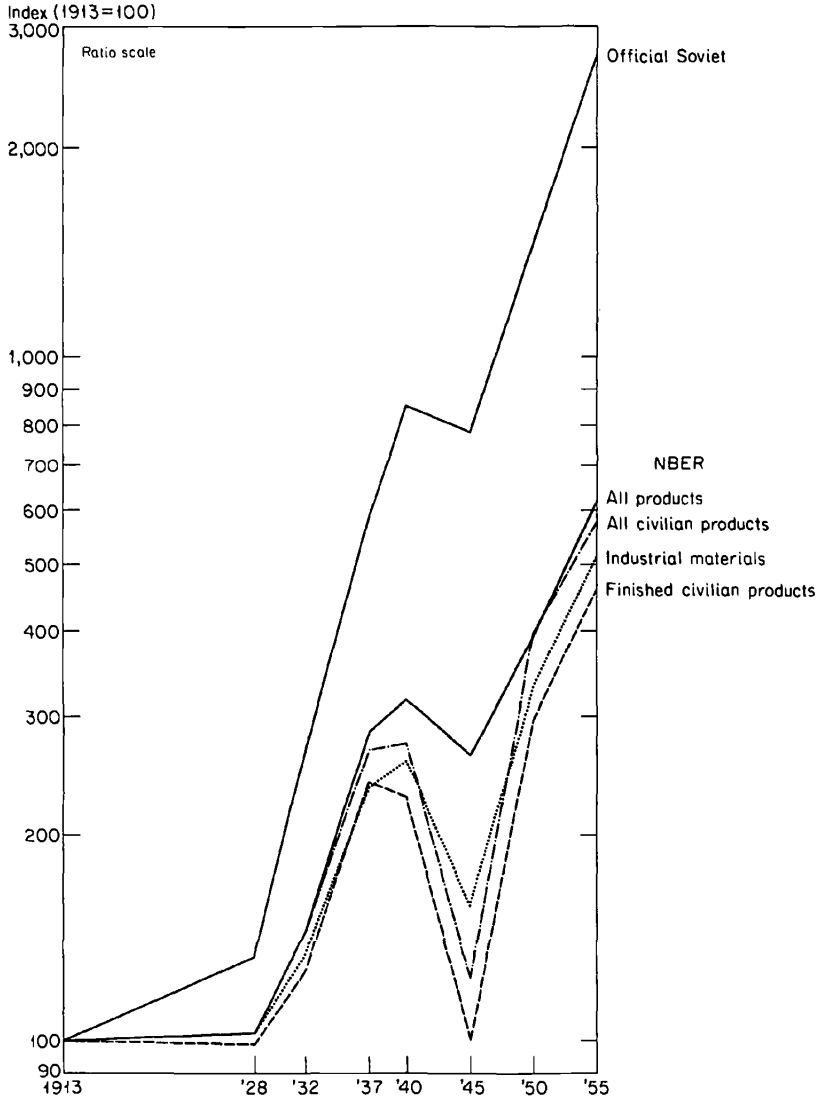
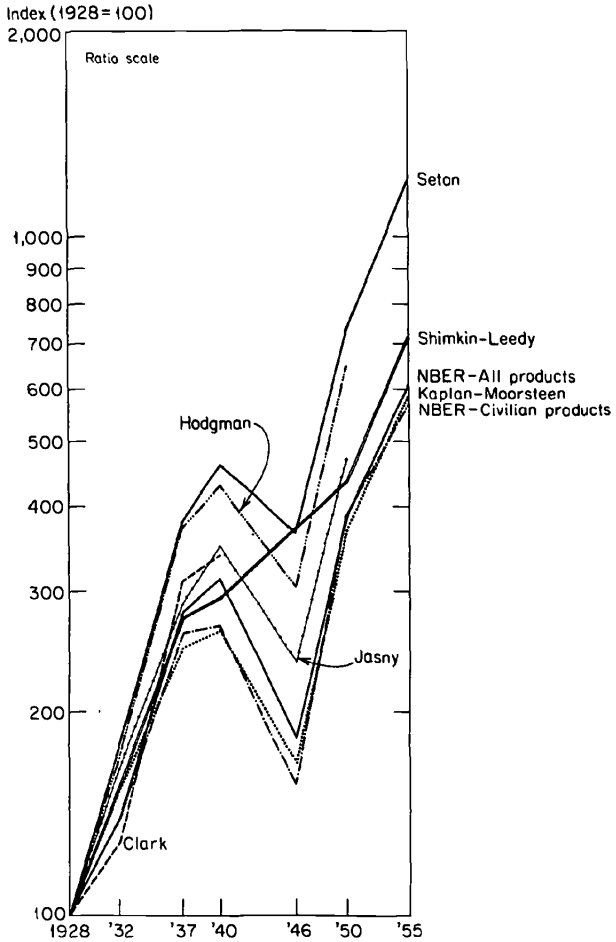


CHART 14 (concluded)

B. NBER and Other Western Indexes, 1928-1955



Source: Tables 32 and 33.

are as follows: 1913–1955, 8.2 and 4.4 per cent; 1928–1955, 11.9 and 6.9; 1928–1940, 16.8 and 9.9; 1940–1955, 8.1 and 4.6; 1928–1937, 18.1 and 12.1; and 1950–1955, 13.1 and 9.6.

INDEXES BY WESTERN SCHOLARS

Six production indexes constructed by Western scholars are presented in Table 33. Each of them tends to rise more rapidly over the long run than our moving-weight index for all industrial products, though less rapidly than the official Soviet index (see Table 32 and Chart 14).

TABLE 33

COMPARISON OF NBER AND OTHER WESTERN INDEXES OF INDUSTRIAL PRODUCTION: SOVIET UNION, BENCHMARK YEARS, 1928–1955

	C. Clark[a]	Jasny[b]	Hodgman[c]	Shimkin-Leedy[d]	Seton[e]	Kaplan-Moorsteen[f]	*NBER, All Products*[g] Civilian	*NBER, All Products*[g] Total
				INDEX (1928 = 100)				
1928	100	100	100	100	100	100	100	100
1932	128	165	172		181	154	140	140
1937	310	287	371	274	380	249	261	279
1940	339	350[h]	430	294	462	263	267	312
1946		236	304		365	168	156	183
1950		470[i]	646	434	733	369	387	385
1955				715	1,210	583	563	608
				LINK RELATIVE (INITIAL YEAR OF PERIOD = 100)				
1928–1932	128	165	172		181	154	140	140
1932–1937	242	174	216		210	162	186	199
1937–1940	109	122	116	107	122	106	102	112
1940–1946		67	71		79	64	58	59
1946–1950		199	212		201	220	248	210
1950–1955				165	165	158	145	158

[a] Colin Clark, *The Conditions of Economic Progress*, 2d. ed., London, 1951, p. 186.

[b] Naum Jasny, "Indices of Soviet Industrial Production, 1928–1954" (mimeographed), Council for Economic and Industry Research Report A-46, Washington, 1955, pp. 40 ff.

[c] Hodgman, *Soviet Industrial Production*, p. 89. His adjusted index for large-scale industry.

[d] Shimkin and Leedy, "Soviet Industrial Growth," p. 51. Includes estimated military production.

[e] Seton, "Tempo of Soviet Industrial Expansion," p. 30.

[f] Kaplan and Moorsteen, "Indexes of Soviet Industrial Output," p. 235.

[g] Moving-weight index for all industrial products, excluding miscellaneous machinery.

[h] For 1939 territory, 330.

[i] Earlier estimates by Jasny were 427 and 444. With "1926/27 American prices," the estimate is 411. See his "Indices," pp. 40–42.

The indexes have been constructed by widely differing methods. Colin Clark's index, being one of the earliest, is based on a very small sample of industries—twelve for the period 1928–1937—weighted together by his "international units." Naum Jasny's index is based partly on output series weighted by his Soviet "real 1926/27 prices," and partly on adjustments of various official Soviet aggregates.[46] Francis Seton's index is derived from the growth rates for three physical output series (fuel and hydroelectric power in calories, steel, and electricity) and the multiple correlation of these growth rates with the growth rate for all industrial production as calculated for a sample of fourteen Western countries over three time periods.

[46] For more details on these two indexes, see Naum Jasny, "Indices of Soviet Industrial Production, 1928–1954" (mimeographed), Council for Economic and Industry Research Report A-46, Washington, 1955.

The Hodgman, Shimkin-Leedy, and Kaplan-Moorsteen indexes are constructed along conventional lines comparable to those we have followed. The Hodgman index covers large-scale industry in 1928, with the coverage expanding to total industry by around 1933 and thereafter. The product coverage falls off sharply after 1937 because of the limited sample of data available at the time the index was computed. In 1937, 137 products are covered; in 1940, twenty-two; and in 1950, eighteen.[47] He makes some admittedly tenuous adjustments to cover estimated armaments production. As weights he uses 1934 Soviet wage-bill data adjusted to include payroll taxes of various types, except for internal weighting of machinery as described in the earlier section of this chapter on machinery and equipment. Weights are fully imputed throughout all industrial categories to the represented output series, with an additional imputation to the metalworking sector to correct a presumed underweighting by wage-bill data. His index, therefore, differs from ours in a number of respects.

The Shimkin-Leedy index uses a modified version of Hodgman's weights and also includes estimated military production. The product series used seem to cover all industry, rather than large-scale industry. Unfortunately, the details underlying this index have not yet been made fully available, so that we cannot investigate the reasons for its differences from ours, which occur primarily over 1937–1955.

For partly different reasons, we are also unable to rationalize the differences between the Kaplan-Moorsteen index and ours. In this case, the former was published after this study had been completed—the details for the machinery segment have not yet appeared—so that systematic comparisons could not be undertaken. It is a comprehensive index covering civilian products and based on 1950 Soviet weights. A somewhat more informative description is given in the annex to technical note 4 of Appendix A, where their sector indexes are compared with ours. We may note here that their aggregate index rises, over the long run, at a rate between those for our indexes for all civilian products with 1928 and 1955 weights, though Kaplan and Moorsteen seem to feel that the similarity to our index with 1955 weights is less than should be expected on the basis of the closeness of the weight bases.[48]

A large portion of the difference between Hodgman's and our indexes is traceable to his adjustments for presumed undercoverage of the metalworking and armaments sector. We see from Table 34 that his unadjusted

[47] Hodgman, *Soviet Industrial Production*, p. 81.

[48] See Kaplan and Moorsteen, "Indexes of Soviet Industrial Growth," p. 79. This question also is commented on in the annex to technical note 4, Appendix A.

TABLE 34

COMPARISON OF NBER AND HODGMAN INDEXES OF INDUSTRIAL PRODUCTION: SOVIET UNION, BENCHMARK YEARS, 1928–1950

	Original Hodgman Index		*Hodgman-NBER Index*[a]		*NBER Index*[b]		
					All Civilian Products		All Products
	Adjusted[c]	Unadjusted[d]	A	B	A	B	A
	INDEX (1928 = 100)						
1928	100	100	100	100	100	100	100
1932	172	163	138	150	140	143	143
1937	371	342	267	283	261	265	279
1940	430	351	289	305	267	272	312
1950	646	527	406	458	387	411	385
	LINK RELATIVE (INITIAL YEAR OF PERIOD = 100)						
1928–1932	172	163	138	150	140	143	143
1932–1937	216	211	194	189	186	185	195
1937–1940	116	103	108	108	102	103	112
1940–1950	150	150	141	150	144	151	123

[a] NBER series combined with Hodgman's unadjusted weights (see Table A-15). Miscellaneous machinery excluded from index marked A and included in index marked B.

[b] Moving-weight indexes. Miscellaneous machinery excluded from indexes marked A and included in indexes marked B.

[c] Hodgman, *Soviet Industrial Production*, p. 89. Adjusted for estimated incomplete coverage of the metalworking and armament sector. For adjustments, see *ibid.*, pp. 71–74 and 85–89.

[d] *Ibid.*, pp. 84 and 237. Not adjusted for uncovered metalworking products and armaments.

index for 1950 is almost 20 per cent lower than his adjusted index. In order to trace out additional sources of divergence, we have computed a new index using his wage-bill weights and our output series, without adjusting for presumed undercoverage of the metalworking and armaments sector. This new index, which is comparable in construction with Hodgman's unadjusted index, approaches ours much more closely than Hodgman's original index. The major source of divergence between our indexes and Hodgman's index would therefore seem to be the differing scope of output series. Since our series are designed to cover total output in all years, they show a slower growth in some sectors than his series, which cover only large-scale output in earlier years.[49] More detailed comparisons for industrial sectors, as given in technical note 4 of Appendix A, support this conclusion even more strongly. It should be noted

[49] Adam Kaufman has constructed a production index for industrial materials produced in the large-scale sector, with 1928 weights and the same product coverage as our index of industrial materials. His index shows a rise of 71 per cent over 1927/28–1933, which may be compared with a rise of 78 per cent in Hodgman's "unadjusted" index and 92 per cent in his "adjusted" one (see A. Kaufman, "Small-Scale Industry in the Soviet Union," NBER [in press], Table 17, and Hodgman, *Soviet Industrial Production*, p. 73).

that the new Hodgman-NBER index is lower than Hodgman's original despite the fact that we have substituted our faster-growing machinery sector for his (see Table 29). As a by-product, we have in the new hybrid index another example of the effect of the weighting system on the movement of an index of Soviet industrial production.

Concluding Remarks

We have tried in this chapter to present a fairly detailed account of the problems involved in measuring the aggregate growth of Soviet industrial production and the ways we have met these problems. It will have become clear that any aggregative index one might construct is bound to be less reliable than those for many Western countries because of the peculiar shortcomings of Soviet statistics, the unique organizational structure of the Soviet economy, and the unusual nature of Soviet industrial growth. For this reason we have calculated a variety of production indexes with differing scope and weighting systems, in the belief that the configuration of results is more meaningful than the set of figures presented by one index alone. Fortunately, a reasonable pattern of evidence does emerge, and there is a certain convergence of results allowing us to proceed with the analysis. Nevertheless, we must constantly view the numbers before us as blurred outlines rather than as the sharp figures they appear to be. Many estimates, assumptions, and inferences have had to be made in building the foundation of basic data from which the index numbers have been constructed, and undoubtedly many errors have been made in the process and in subsequent calculations, some discovered and some not. It is in a mood of caution, then, that we move on to the job of interpreting the collected evidence.