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A Comparison of Soviet and US Industrial Performance: 1928-90

Research Memorandum GD-29

Remco Kouwenhoven

Groningen Growth and Development Centre
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May 1996 1997

A Comparison of Soviet and US Industrial Performance, 1928-90*

by

Remco Kouwenhoven**

Abstract

This paper contains detailed estimates of comparative labour productivity levels in manufacturing and mining for the Soviet Union and the USA in 1987 as well as rougher estimates for residual industrial activity. Value added was converted to a common currency using a purchasing power parity derived by the industry of origin approach. The benchmark figures were merged with adjusted CIA time series for Soviet value added and labour inputs and with Department of Commerce series for US value added and labour inputs. In this way relative Soviet/US productivity levels can be measured back to 1928.

A detailed annex is available on request.

* I want to thank Angus Maddison for his inspiration and close cooperation in carrying out this complicated research. I also want to thank Bart van Ark for his helpful comments and suggestions throughout the research, and for organising a research trip to Moscow on the results of which the core of this study is based. Further, the author wishes to thank the following persons for their help and co-operation: Ludmila Jakovlevna Antsiferova, Peter Boelens, Mark Harrison, Tatjana Alekseevna Homenko, Youri Nikolaevich Ivanov, Valentin Mikhailovich Kudrov, Victor Ivanovich Merkulov, Tamara Igorevna Minskaya, Nanno Mulder, Stephen Rapawy, and Gertrude Schroeder. The research for this paper was partly conducted during a visit to CIS-STAT in Moscow which was financed by INTAS under number INTAS-93-2487, title: Productivity Performance and Potential of the Independent States of the Former Soviet Union. All remaining errors are my sole responsibility

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1 Introduction

This paper contains estimates of comparative industrial labour productivity levels for the Soviet Union and the USA¹. The bulk of the effort concerns manufacturing. The main findings are that in 1987 Soviet value added in manufacturing was 42.5 per cent of that in the USA and value added per person employed was 24.8 per cent of American levels. Soviet working hours appear to have been shorter and value added per hour was 26.3 per cent of the USA. For industry as a whole, Soviet value added per employee was 26.3 per cent of the USA; per hour worked this was 26.8 per cent.

It appears that over the period 1928-1989 the position of Soviet industry hardly improved relative to US manufacturing. Soviet value added per hour worked remained below 30 per cent of the US level for most of the period, and was 26.9 per cent in 1989. In the post-war period, Soviet value added per hour worked came closest to the US in 1980, with a relative percentage of 29.7.

Table 1
Results of Recent ICOP Comparisons of Productivity in Manufacturing, 1987, USA=100

	Value Added per Person Employed
China	4.5
India	7.2
Indonesia	10.0
Hungary	20.1
Poland	21.1
East Germany	22.5
Czechoslovakia	23.9
Portugal	24.5
USSR	24.8
Korea	26.3
Brazil	30.7
Mexico	34.2
Spain	46.5
Australia	48.4
United Kingdom	53.6
Finland	65.9
Sweden	68.4
West Germany	70.2
France	71.2
Japan	76.4
Canada	77.3
Netherlands	83.3
United States	100.0

Source: USSR/USA from table 13, other comparisons from Van Ark et al., 1996, table 1.

Several comparisons of labour productivity in manufacturing that involve formerly communist command economies have been conducted within the ICOP project². These studies have benefited from the new statistical openness of the East European countries. They are therefore based on information which was not available to Western researchers before. Table 1 shows labour productivity results of almost all ICOP studies that have been carried out for manufacturing so far. In most of these studies the USA was the base country. Binary comparisons that had other countries as base country, have been recalculated to be made comparable to the US based comparisons. From this table, it appears that Soviet productivity performance in 1987 was comparable to that of Portugal and just below that of Korea.

¹ This study is part of the research project: 'Levels and Growth in the Former Soviet Union: A Long Run Comparative Perspective', which is a joint endeavour of the Groningen Growth and Development Centre, the Russian Academy of Sciences (Valentin Kudrov) and CIS-STAT (Youri Ivanov).

² International Comparison of Output and Productivity, more on ICOP in section 5 below.

2 Previous Estimates

A number of previous estimates of Soviet industrial productivity relative to the United States are available (see table 2)³. Galenson (1953, 1955), Kats (1959 and 1964), and Schroeder (1962 and 1964) compared output in physical units. A disadvantage of this method is that only fairly homogeneous products and branches can be compared. Schroeder for instance criticised Kats because he included branches for which productivity comparisons in physical units are questionable (Schroeder, 1962, p. 154). Another disadvantage is the difficulty in averaging the results to arrive at a figure for total manufacturing. The three studies cited above computed an average using both Soviet and US employment weights. Schroeder (1964) mentioned several Soviet/US labour productivity comparisons that have been carried out by Soviet researchers. These authors, however, provided no detailed description of their methodology and/or their basic data, and were therefore not included in my overview.

Galenson (1955) estimated physical output per wage earner for sixteen industries. Where possible, he adjusted for differences in quality and product mix. He showed 1936 Soviet productivity in these industries to have been between 58 per cent of the US for tractors and 15 per cent for heavy construction machinery (ibid., table 79). Both unweighted and weighted by Soviet employment, his average Soviet productivity estimate for these 16 branches in the late 1930s was 40 per cent of the US level⁴.

Schroeder (1964) estimated Soviet physical output per production worker relative to the USA for 1956 for 25 branches of industry and compared her results with the figures obtained by the Soviet economist Kats (1959 and 1964), who based his estimates on roughly the same branches. After making a few adjustments for differences in quality⁵ and product mix between the two countries, her average ratio (29.5 per cent) was considerably below that of Kats (47.9 per cent). The difference between her results and Kats' could not be explained because she could not replicate most of his estimates. Nevertheless, Schroeder used Kats' implicit employment estimates for 14 of her 25 branches.

In contrast to the three authors mentioned above, Nutter (1962) used both quantity and value data⁶. To convert output valued in rubles and dollars to a common currency, he used what he called 'ruble-dollar ratios'. These ruble-dollar ratios were derived for 45 sample industries from his value added series (ibid., table A-26). For each of his 45 industries, US value added in dollars was multiplied by the ratio of Soviet to US physical output to arrive at Soviet value added in dollars:

$$(1) VA_j^{usa\$} * \frac{Q_j^{ussr}}{Q_j^{usa}} = VA_j^{ussr\$}$$

($VA_j^{usa\$}$ stands for US value added in industry j valued in US dollars, Q_j^{ussr} stands for Soviet quantities in industry j, \$ and R means valued in dollars and rubles respectively).

Similarly, Soviet value added was multiplied by the ratio of US to Soviet physical output to arrive at US value added in rubles:

$$(2) VA_j^{ussrR} * \frac{Q_j^{usa}}{Q_j^{ussr}} = VA_j^{usaR}$$

³ See Kudrov (1995) for an overview of both Soviet and Western literature on USSR/USA comparisons.

⁴ To sum the output of different products he used several weighting schemes. For instance, for the iron and steel branch Galenson used weights based on the value added per unit of output as calculated on the basis of US data (Galenson, 1955, p. 117-121).

⁵ Schroeder (1962 and 1964) made some quality adjustments. Textile was measured in square metres instead of length, dairy products were measured in milk equivalents, and crude petroleum and natural gas were measured in standard fuel equivalents. From these studies it is unclear what impact these quality adjustments had on the results.

⁶ He derived his value of output or value added as output times unit value or unit value added.

Combining and rewriting (1) and (2) gives either:

$$(3) \frac{P^{USSR} * Q^{USSR}}{P^{USA} * Q^{USSR}}$$

which is identical to (5), in section 5 below, for an individual product, or:

$$(4) \frac{P^{USSR} * Q^{USA}}{P^{USA} * Q^{USA}}$$

which is identical to (6), in section 5 below, for an individual product. This means that Nutter's method of deriving a conversion factor for an industry is approximately the same as the ICOP method for deriving a unit value ratio (or purchasing power parity) for each individual product which I used (see section 4). However, he did not differentiate his analysis by product but derived his ratios by industry (e.g. paper). My (ICOP) procedure is to measure output of products (e.g. pulp, bleached pulp, unbleached sulphite pulp, newsprint, offset paper, bond and writing paper, unbleached kraft paper, and paper board) whereas Nutter used a single indicator (paper) for each industry. In fact Nutter was more interested in time series than in level estimates. The latter covered 45 products and were done more crudely than his series for 119 products. Nutter made no adjustments for quality differences. A serious weakness in his method is that his sample did not include machinery and equipment industries⁷. He alleviated this problem by using ruble-dollar ratios for these industries, as estimated by Becker⁸. Nutter aggregated the ruble-dollar ratios for his 45 industries by using value added weights. This result was averaged with the ruble-dollar ratios for machinery as derived from Becker (1959) using persons engaged as weights (Nutter, 1962, table A-31).

Nutter's benchmark estimates of levels were intended mainly to check the results of his time series. For the benchmark years (1913, 1928, and 1955) he compared value added per man-hour engaged in industry. He defined industry in the Soviet way, i.e. including manufacturing, mining, logging, fishing, and power supply. Industrial value added was calculated as *'the sum of employee compensation, profits, and net 'commercial' and unallocated outlays, all of which are rather indirectly derived'* (ibid., p. 237). Nutter concluded that the level of Soviet value added per hour worked in 1955 was a little over 19 per cent of the USA. For the same year I estimated Soviet value added per hour worked in industry as a little under 22 per cent of the US level.

Under the supervision of Valentin Kudrov, the Institute of World Economy and International Relations (IMEMO) of the Soviet Academy of Sciences conducted a detailed comparison of Soviet and US economic performance (IMEMO, 1975). In that study, productivity was defined as gross output per production worker. IMEMO's conversion method was based on comparing quantities of individual products valued at both Soviet and US prices. These parities were used to convert gross output to a common currency. IMEMO's aggregate result showed that 1963 Soviet productivity in industry was about 35 per cent of the USA. As in Nutter's study, industry was defined according to the Soviet classification. This IMEMO study was not published as it was considered by the authorities to give an unfavourable view of Soviet performance⁹.

⁷ Therefore it also excludes military production.

⁸ Becker (1959) computed ruble-dollar ratios based on a large sample of machinery using the US basket of goods. Nutter assumed that the same ratios would apply to the Soviet basket of goods, and accordingly estimated such a ratio for machinery (Nutter, 1962, p. 380).

⁹ A copy is now available in the library of the Economics Faculty, University of Groningen.

Table 2
Industrial Labour Productivity Comparisons 1954-95, USSR/USA

Study	Productivity concept	Productivity (Soviet labour productivity as percentage of US) and benchmark year	Number of products sampled	Sample size	Source used for USSR
Galenson (1955)	Physical output per wage earner in industry. Average is derived using both Soviet and US employment weights.	40 (1936-1939) (a)	23	16 industries, 17% of US industrial gross output in 1939 (b)	Official data, technical journals, statistical yearbooks
Nutter (1962)	Industrial value added per man-hour engaged, valued both in Soviet and US prices.	19.3 (1955)	119 (c)	45 industries, 50 % of Soviet value added and 28 % of the US	Official Soviet sources
Schroeder (1962, 1964)	Physical output per production worker in industry. Average is derived using both Soviet and US employment weights.	29.5 (1956) (d)	Awaiting confirmation from Gertrude Schroeder	25 branches of industry, 34% of Soviet production workers, 22% of US production workers	Output from official publications, employment derived from Kats.
Kats (1959, 1964)	Physical output per production worker. Average is weighted by Soviet employment.	47.9 (1960) (e)	139	27 branches of industry, 40% of Soviet production workers (f)	Official sources
Revenko (1966)	Gross output per employee and per employee hour worked, valued both at Soviet and US prices	per employee: 47 per employee hour: 49, both for 1960 (g)	263	52% of Soviet gross output in 1960, 45% of US output in 1958 (h)	Official sources
Kudrov (1969)	Gross production per worker in industry, valued at both Soviet and US prices	35 (1963)	224 (i)	substantial, but not stated	Unpublished sources
IMEMO (1975)	Gross output per employee in industry, valued at both Soviet and US prices	34.6 (1963)	255 (j)	unknown	Unpublished sources
Kouwenhoven (1995)	Manufacturing value added per employee hour worked, value at both Soviet and US prices	26.3 (1987)	132 (k)	18% of Soviet gross output, 16% of US gross output (l)	Unpublished data provided by CIS-STAT

(a) Unweighted average of the 16 industries. Same figure for the 16 industries averaged by Soviet employment weights.

(b) Galenson includes three mining industries (coal, iron ore, oil and natural gas).

(c) This is the number of products Nutter (1962, table 22) sampled to estimate his time series.

(d) The average of the 25 branches was 28 per cent weighted at Soviet employment and 31 per cent at US employment. Soviet productivity ranged from 12 per cent of USA for synthetic rubber to 74 per cent for rubber footwear.

(e) The average of the 27 branches weighted at Soviet employment. Soviet productivity ranged from 12.1 per cent of USA for synthetic rubber to 135.1 for bread and bakery products.

(f) Almost all machine building was omitted, as were non-ferrous metallurgy, electrical power, and most of the chemicals industry (from Schroeder, 1964).

(g) Fisher averages calculated by Kouwenhoven.

(h) Revenko used Soviet data for 1960 and US data for 1958. He updated the US figures to 1960 using a productivity index for 1958-1960.

(i) Van Ark and Maddison (1994).

(j) Summed up for 9 branches (machinery and metal working, construction materials, wood and paper products, glass and porcelain, light industry, and food industry) from: IMEMO (1975) table II, page 214.

(k) See appendix B in this study.

(l) From table 4 of this study.

Bergson (1972a and 1973) presented productivity results for industry too. However, he used a very broad definition of industry, including not only manufacturing, mining, and power supply, but also construction, trade, and transport and communications. This makes a comparison with my result difficult, and therefore I did not include his work in table 2. Bergson (1973) estimated that 1960 Soviet gross product per employed worker was 27.3 per cent of the US at 1955 ruble factor costs, and 48.3 at 1955 dollars¹⁰.

¹⁰ Gross product was defined by Bergson (1973, p. 179) as 'gross national product as usually understood in national income accounting'.

As can be seen in table 2 there is a wide range of results in these earlier studies: from a Soviet productivity of 50 per cent of the USA estimated by Revenko for 1960 (whose methodology I could not check in detail), to 19 per cent for 1955 by Nutter. It is difficult to compare these earlier studies, since they cover different years. But all of them, except Nutter, show better relative performance for the Soviet Union than I do. To better compare my results, which I describe in more detail below, with the earlier estimates, I linked my 1987 benchmark result with Soviet and US time series for value added in industry and total hours worked for 1928-1990¹¹. Graph 1 shows that my results are fairly close to Nutter, relatively close to Schroeder, IMEMO and Kudrov, but quite different from Galenson, Revenko and Kats.

Unlike most earlier studies my concept of labour productivity is value added per unit of labour input. Of the studies in table 2, Nutter (1962) was the only researcher to have followed approximately the same method¹². The other authors compared either physical output (Galenson, Schroeder, and Kats) or gross output (Kudrov and IMEMO). To arrive at value added, I deducted the value of intermediate inputs (i.e. raw materials, energy, etc.) from the gross value of output (see appendix A.1 for a detailed description of the definitions). Using my data set, I estimated Soviet gross output per employee in manufacturing to have been 35 per cent of the USA. This is a good deal higher than the 24.8 per cent I derived for value added per employee (from table 10). Other ICOP studies of Eastern European countries show the same phenomenon, i.e. higher ratio of intermediate inputs to gross output than in Western countries¹³. This means that if these earlier studies had been carried out on the basis of value added instead of gross output, they would probably have shown lower productivity results. When this is taken into account, there is a much smaller problem of reconciling my results with those of earlier authors.

Another reason for differences in results is that my estimates are based on Soviet statistics that were not previously available to researchers outside the Soviet government. Most of the earlier studies had to rely on official published statistics from miscellaneous sources¹⁴. Nutter, for instance, relied mainly on officially published material (e.g. *Narodnoe Khozyaistvo, Promyshlennost' SSSR*) and a very wide range of specialised books and articles (his Soviet references included over 600 entries). Galenson used official sources too, supplemented by reports and articles by technical experts. My estimates are based on detailed, unpublished product and industry information provided by CIS-STAT¹⁵. The sources are described in detail in appendix A.2. They were available to me in handwritten form and obtained directly from the enterprise files in the CIS-STAT archives.

¹¹ See section 9.

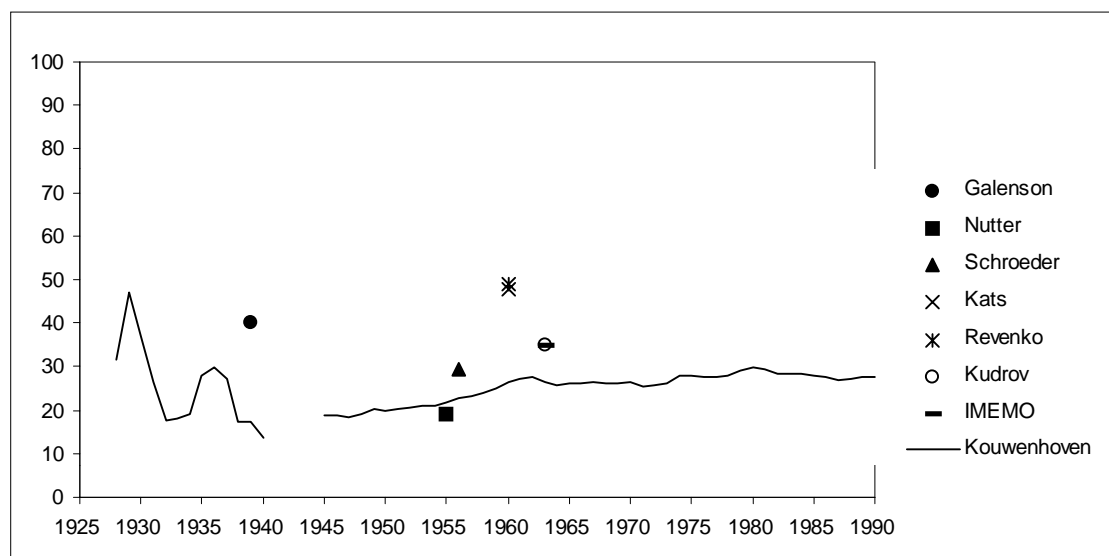
¹² In his 1972b study, Bergson too applied a method that approximates the ICOP procedure to compare Soviet and US national income.

¹³ See Van Ark, 1996.

¹⁴ For an extensive discussion of Soviet economic statistics, see Treml and Hardt (1972).

¹⁵ Interstate Statistical Committee of the Commonwealth of Independent States, the successor of Goskomstat USSR.

Graph 1
Confrontation of My Time Series for the Relative Level of Value Added per Hour Worked with Earlier Estimates of Soviet Labour Productivity in Industry, 1928-1990, USA=100



Source: For productivity concepts and references see table 2. My value added per hour worked series are from table 23.

3 Comparing Soviet and US Industrial Output and Labour Productivity

The present study estimates the performance of Soviet industry relative to the world productivity leader, i.e. the USA. Comparative studies of output and productivity levels which cover communist command economies raise a range of specific problems which are less important or do not exist for comparisons between market economies. These can be summarised as follows¹⁶:

a) Official prices are not determined by market forces but by administrative processes¹⁷. This makes comparing output between market and non-market economies more difficult¹⁸. Comparisons at world prices face substantial problems too, because the quality of exported commodities often deviates strongly from items sold domestically¹⁹. Marer (1985, pp. 27) also notes a sharp dichotomy between Soviet domestic prices and prices in international transactions.

b) The average quality of products in communist countries was generally lower than in Western economies²⁰. However, it has not been documented whether such differences were equally large across the whole range of industry products, including non-durable consumer goods as well as intermediate goods and investment goods. Furthermore, given the administrative nature of the pricing system in the Soviet Union, one cannot be sure to what extent quality differences were not reflected in the prices of the products. For lack of information I made no quality adjustments in the present study. The only author from table 2 who did for the Soviet Union was Schroeder (1962, 1964)²¹. It should be emphasised that

¹⁶ Based on Van Ark (1994), but adapted to the Soviet case.

¹⁷ For a general description of centrally planned price systems see Marer (1985).

¹⁸ Van Ark et al. (1996) show that prices in centrally planned economies are not too different from prices in non-centrally planned economies.

¹⁹ See Hare and Hughes (1994) for a study using the ratios between border prices and domestic prices for Eastern European countries.

²⁰ See for instance the remarks on the difference between Soviet and US quality of goods in Bergson (1972b, pp. 155-156).

²¹ In the ICOP comparisons for Eastern Europe, a crude quality adjustment was made for passenger cars on the basis of the valuation of different East European models on the West German market. See Van Ark (1996) and Van Ark et al. (1996).

part of the 'unmeasured' difference in product quality between the USSR and USA is implicitly accounted for in this study by putting my comparison on a value added basis rather than on a gross output basis. The higher ratio of intermediate inputs to gross output, described above, is partly the result of greater wastage, but it also reflects the low technology content of the products which is compensated for by a more intensive use of intermediate inputs. The latter aspect can be interpreted as an indication of low product quality in the Soviet Union²².

c) It is difficult to reconcile the industry classifications of the United States and the Soviet Union. Most market type economies have a classification which is similar to the International Standard Industrial Classification of All Economic Activities (ISIC)²³, which makes international comparisons between those economies fairly straightforward. The Soviet classification differs markedly from ISIC.

Soviet 'industry' according to OKONKh ('Obshchesoyuznyi Klassifikator Otrashi Narodnovo Khozyaistva', literally: an all-union branch classification for the national economy) consists of manufacturing activities, mining, electrical power supply, fishing, and repair and maintenance activities. The US Standard Industrial Classification (SIC) distinguishes most of these activities as separate divisions²⁴. For this study I adjusted the Soviet classification in such a way as to make it comparable to the classification of the United States. Adjusting Soviet 'industry' to 'manufacturing' not only made it necessary to exclude all non-manufacturing activities (e.g. 'mining of raw materials for chemicals' had to be excluded from the chemical branch), but also to reclassify several Soviet industries (e.g. Soviet 'light industries' were reclassified to 'textiles', 'wearing apparel', and 'leather and footwear'). In appendix A, a description of these adjustments is given²⁵. The annex shows a detailed list of OKONKh industries and a SIC/OKONKh conversion table. In this paper, I focus mainly on manufacturing (section 6), but also present results for mining (section 7), and for industry as a whole (section 8).

d) In Soviet statistics, military output, i.e. the production of aircraft, spacecraft, tanks, bombs etc., was more secret than in the USA. For this study it is important to know whether output of, and employment in military industries are included in our data set. Rosefielde (1990) summarised the debate on this question. He cites Steinberg (1986) who claimed that arms production was excluded from Soviet economic statistics, and Wiles (1987) who took the contrary position that, at least for the period 1959-1972, Soviet statistics included and accurately reported both military output and employment.

My impression is that at least a substantial part of military production is included in my sources, because aircraft production, defence industries, and shipbuilding are included in the OKONKh classification. Although for these industries no detailed information was available, their output and employment can be inferred from the total of the machinery branch by comparing the identified civilian components of the industry with the total²⁶. At CIS-STAT it was explained to me that some parts of the military output were more secret than others. The production of so-called 'closed ministries' was reported to Goskomstat USSR only in a very aggregated form (see appendix A.3). At CIST-STAT it was not known

²² For example, machine tools were often much heavier and bigger in the USSR than in the USA, but the performance in terms of output per machine hour and in terms of constant quality of the products was much less in the USSR compared to the USA.

²³ United Nations (1968).

²⁴ The US industrial classification distinguishes 11 divisions: agriculture, mining, manufacturing, transportation, wholesale trade, retail trade, finance, services, public administration, and nonclassifiable establishments. Soviet OKONKh recognises 9 major divisions: industry, agriculture, forestry, transport, communications, trade, technical materials supply, and 'building of the communal economy'.

²⁵ Table A.6 shows which part of the OKONKh industries are non-manufacturing.

²⁶ On this basis, the military industries form some 35 per cent (84.7 bln rubles) of total output (204.3 bln rubles) and 34 per cent (5.8 mln employees) of employment in of the OKONKh-industry 'machine building'.

whether military production and employment were completely covered in Goskomstat USSR statistics.

e) An important characteristic of the economic system of communist countries is that only 'material' production was considered to be productive²⁷. Therefore Soviet statistics generally ignore 'non-productive' service sector activities in national accounts and national income calculations. This causes considerable difficulties in estimating manufacturing value added on a basis comparable to Western definitions. For a further description on the definition of value added see section 4, and see appendix A for a description of the definitions used.

4 Definition of Value Added²⁸

It should be noted that the estimates of Soviet value added in this study are on an MPS (Material Product System) basis, as inputs were deducted using elements of the 1987 Soviet input-output table²⁹. MPS does not include so-called 'non-productive' sectors, i.e. passenger transport, real estate, health, education, culture, sport, entertainment, government services, technical services, insurance and finance. Most of these, except the last three would not normally be part of industrial inputs, but my estimates of Soviet value added are still somewhat bigger than if the Western national accounts concept of value added had been used. However, Soviet value added in table 15 is smaller than it would be on US census definitions. In the US census, only raw materials and inputs supplied from other industrial establishments are deducted, non-industrial inputs are not deducted. Therefore, the Soviet value added concept lies somewhere between the Western national accounts and the US census concepts of value added. The difference between the Soviet and the US census concepts lies in the fact that Soviet value added excludes non-material inputs, while the US census excludes non-industrial inputs. It is not all together clear how to match these two definitions in detail.

The top half of table 3 shows the difference between the US census and US national accounts estimates of value added. The national accounts deduct all inputs, and their estimate of value added is smaller than that of the census which is gross of non-industrial inputs. The national accounts figure for manufacturing value added was 75.2 per cent of the census figure for manufacturing. For mining it was 84.5 per cent. The differences for persons employed are smaller, and the discrepancy is in a different direction, where the national accounts figures are higher than the census. However, this is not difficult to explain. Apart from the definitional differences in measuring value added, the two sources differ in some other respects. The census is based on *establishment* returns, whereas the national accounts are based on financial returns by *enterprises*. The allocation of output by industry is in both cases based on the main activity of the establishment/enterprise. But there will be discrepancies in the case of multi-establishment enterprises. The other significant difference is that the national accounts include all activities, whereas the census does not cover establishments with no hired labour. This is the reason the national accounts figures for employment are bigger.

²⁷ See Treml and Hardt (1972).

²⁸ For a fuller description of the definitions used in this study see appendix A.

²⁹ An abstract of this input-output table was supplied by CIS-STAT.

Table 3
Confrontation of Value Added and Persons Engaged
on a Census and National Accounts Basis, USA and USSR, 1987

	US Census Value Added (million dollars)	US National Accounts Value Added (million dollars)	US Census Persons Engaged (000s)	US National Accounts Persons Engaged (000s)
Manufacturing	1,165,747	877,800	18,950	19,487
Mining	98,170	83,000	700	745
Utilities	n.a.	139,500	n.a.	929
	Soviet 'Census' Value Added (million rubles)	Soviet 'National Accounts' Value Added (million rubles)		
Industry	570,801	336,941		

Source: US figures from tables 6, 13, 14 and 21; Soviet figures from 1987 input-output table, see annex.

The lower half of table 3 shows a confrontation of 'census' and 'national accounts' style Soviet value added. Soviet 'census' style value added was derived by deducting all industrial inputs from gross output, while Soviet 'national accounts' style value added was derived by deducting both industrial and non-industrial inputs from gross output³⁰. Soviet 'national accounts' value added was 59 per cent of 'census' style value added. Let it be clear that both these estimates are still derived from an SNA data set, and that therefore non-material activities are not accounted for. Since these non-material activities are neither included in the outputs, nor in the inputs, it is not clear in what direction the bias might go.

5 Methodology, Benchmark Year, and Coverage

*Methodology*³¹

To convert Soviet output in rubles to dollars, and American output in dollars to rubles, I calculated unit value ratios (UVRs)³² which are based on ratios of ex-factory sales values per unit of output for as many industrial products as could be matched between the Soviet Union and the United States³³. Using the value and quantity information from the respective censuses, I calculated implicit prices (unit values) in rubles and in dollars. For each matched product, I divided the value in Soviet prices by the Soviet quantity times the relevant US unit value. I derived unit value ratios between the two countries by dividing the individual ruble unit value by the corresponding dollar unit value.

Individual product UVRs (e.g. milk or butter) were aggregated to the industry level (e.g. dairy products) using quantity weights of either the Soviet Union or the United States.

³⁰ Data from 1987 soviet input-output table in the annex.

³¹ The methodology is based on the ICOP procedure. For a detailed methodological description see Maddison and Van Ark (1988), Van Ark (1993a) and Maddison and Van Ark (1994).

³² Also referred to as purchasing power parities, or PPP's.

³³ In the case of the Soviet Union, UVRs are based on ex-factory producer prices per unit of output, see appendix A.

$$(5) UVR_j = \frac{\sum_{i=1}^s P_{ij}^{USSR} * Q_{ij}^{USSR}}{\sum_{i=1}^s P_{ij}^{USA} * Q_{ij}^{USSR}}$$

(UVR_j is the unit value ratio in industry j, $i=1...s$ is the sample of matched items i in matched industry j, Q_{ij}^{USSR} is Soviet quantity of product i in industry j, P is unit value).

at quantity weights of the Soviet Union (or Paasche UVR), and:

$$(6) UVR_j = \frac{\sum_{i=1}^s P_{ij}^{USSR} * Q_{ij}^{USA}}{\sum_{i=1}^s P_{ij}^{USA} * Q_{ij}^{USA}}$$

at quantity weights of the USA (or Laspeyres UVR).

The second stage of aggregation from industry to branch level (e.g. food) was made by weighting the unit value ratios as derived above, by value added in each industry in the Soviet Union or the USA, i.e.:

$$(7) UVR_k = \frac{VA_k^{USSR}}{\sum_{j=1}^r [VA_j^{USSR} / UVR_j]}$$

(UVR_k is unit value ratio in branch k, UVR_j is the unit value ratio for gross output of industry j, $j=1...r$ are the industries j in branch k)

for the Paasche UVR of branch k at Soviet weights, and:

$$(8) UVR_k = \frac{\sum_{j=1}^r [UVR_j * VA_j^{USA}]}{VA_k^{USA}}$$

for the Laspeyres UVR of branch k at US weights. Finally, the branch UVRs were aggregated to a total for manufacturing using branch value added weights. I used the Fisher average to summarise the two resulting ratios.

The UVRs for gross output were assumed to be valid for value added (gross output minus intermediate inputs) which implies that the UVR's for gross output were assumed also to be representative for intermediate inputs.

Benchmark Year

The year 1987 was chosen as benchmark mainly for practical reasons. For this year a US census of manufactures and mining was available, and CIS-STAT could supply detailed Soviet product and industry data. Also, for this year, for both the USA and the USSR a detailed input-output table was available.

1987 was one of the last years in which the Soviet command economy functioned more or less in full shape. CIS-STAT claims that this was the last year in which their reporting system had a complete coverage of enterprises.

Coverage

This study covers 16 branches of manufacturing, using 132 product matches for manufacturing, and 6 product matches for mining. The ICOP comparisons cited in table 1 have varying degrees of coverage as shown in table 5 below for East European countries.

Table 4 shows the coverage of my sample. The 132 manufacturing items cover 18.5 per cent of Soviet gross value of output and 16.3 percent of US output. The matched shares differ substantially both between branches and between the two countries. For a branch

with relatively many homogeneous products, like tobacco, the matched items cover a large part of total output, but this is not so in branches with many diversified products, such as textiles or machinery, where it was more difficult to attain such a high proportion of matched items.

Table 4
Unit Value Ratios and Matched Output as % of Total Output
by Manufacturing Branch and Industrial Sector, USSR/USA, 1987

	Number of Unit Value Ratios	Matched Output as % of Branch Gross Value of Output		Unit Value Ratios (Rubles/US\$)		
		USSR	USA	At USSR	At US	Geometric Average
				Quantity Weights	Quantity Weights	
Food Manufacturing	33	39.6	28.6	0.608	0.768	0.683
Beverages	5	32.9	41.8	1.132	0.870	0.992
Tobacco Products	2	92.0	85.6	0.347	0.308	0.327
Textile Mill Products	4	0.9	2.9	0.989	1.030	1.009
Wearing Apparel	11	24.7	26.5	0.699	0.828	0.761
Leather Goods & Footwear	3	47.0	30.7	0.397	0.393	0.395
Wood Products, Furniture & Fixtures	10	15.0	12.9	0.460	0.554	0.505
Paper Products	8	33.5	18.4	0.735	0.776	0.755
Chemicals & Allied Products	11	30.3	7.7	0.871	0.925	0.898
Rubber & Plastics	2	4.2	6.8	0.522	0.566	0.544
Oil refinery	3	43.1	65.5	0.319	0.316	0.317
Non-metallic Mineral Products	6	7.7	10.2	0.420	0.376	0.397
Basic & Fabricated Metal Products	16	18.7	10.5	0.366	0.428	0.396
Machinery & Transport Equipment	13	3.9	16.2	0.216	0.239	0.227
Electrical Machinery & Equipment	5	1.9	1.6	0.684	1.064	0.853
Other Manufacturing Industries	0	0.0	0.0	0.346	0.599	0.455
Manufacturing	132	18.5	16.3	0.346	0.599	0.455
Mining	6	67.8	57.3	0.259	0.257	0.258
Public Utilities	0	0	0	0.331	0.573	0.435
Industry	138			0.331	0.573	0.435

Source: Manufacturing and mining UVRs and matching percentages derived from the annex; the UVR for public utilities is the value added weighted average of the manufacturing and mining UVRs. See appendix B for a detailed description of the matches per branch.

Table 5
Coverage of Recent ICOP Comparisons in Manufacturing

	USSR/USA 1987	Czechoslovakia/ West Germany 1989	East Germany/ West Germany 1987	Hungary/ West Germany 1987	Poland/ West Germany 1989	West Germany/ USA 1987
Matched output as percentage of total manufacturing output						
- Country in numerator	18.5	32.0	41.1	33.1	33.6	24.4
- Country in denominator	16.3	23.2	33.7	19.3	19.4	24.8
Number of product matches	132	69	335	383	236	271
Matched output as percentage of total output in the machinery and equipment branch						
- Country in numerator	3.7	16.0 (a)	21.7	14.8	14.4	24.9
- Country in denominator	12.8	19.4 (a)	27.6	9.5	15.0	18.7

Notes: (a) Includes metal products

Source: USSR/USA from table 4, West Germany/USA from Van Ark and Pilat (1993), other comparisons from Van Ark et al. (1996)..

There are three possible ways to assess the adequacy of coverage: (1) the share of matched output in total manufacturing output; (2) the total number of product matches³⁴; and (3) the ratio of matched to gross output in the machinery and equipment branch. The latter branch is very large and contains a wide range of heterogeneous products. It is not easily represented by a small number of product matches.

³⁴ The number of product matches is not necessarily the same as the number of products, since a product match can include several products, as can be seen in the annex.

The present study covers a lower proportion of output than any of the other studies in table 5. I got more product matches than that in the Czechoslovakia comparison but less than in the East Germany, Poland and Hungary comparisons. The product matches are described in appendix B and are presented in full detail in the annex.

6 Manufacturing

Table 6 shows levels of gross output, value added and productivity in national currencies, and the number of persons engaged in Soviet and American manufacturing in 1987 as derived from census material. When expressed at its own prices, 'machinery and transport equipment' was clearly the biggest branch in both countries, both in terms of output and employment. Productivity in Soviet machinery was below that of total manufacturing, while in the US its productivity was slightly above average. The relative standing of the textiles, apparel and leather branches was better in the USSR than in the USA for all three indicators, in the Soviet Union these branches combined had a productivity level only 72 per cent of that of total manufacturing; in the US this relative standing was lower, at 52 per cent.

Table 6
Gross Value of Output, Value Added and Productivity in National Currencies (at producer prices)
and Persons Engaged by Manufacturing Branch, USSR and USA, 1987

	USSR				USA			
	Gross Value of Output	Value Added	Persons Engaged	Value Added per Person Engaged (Rubles)	Gross Value of Output	Value Added	Persons Engaged	Value Added per Person Engaged (US\$)
	(in million Rubles)		'000s	(Rubles)	(in million US\$)		'000s	(US\$)
Food Manufacturing	133,556	24,329	2,910.1	8,360	282,398	99,018	1,384	71,563
Beverages	11,077	1,998	311.8	6,407	47,327	22,585	173	130,302
Tobacco Products	4,719	490	38.7	12,657	20,757	14,264	64	224,627
Textile Mill Products	62,653	11,827	1,997.9	5,920	62,786	25,660	699	36,715
Wearing Apparel	33,129	9,507	2,336.1	4,070	64,243	32,516	1,114	29,193
Leather Goods & Footwear	13,158	3,922	677.7	5,787	9,082	4,378	136	32,262
Wood Products, Furniture & Fixtures	30,582	13,472	2,535.0	5,314	107,209	48,975	1,235	39,653
Paper Products	7,809	3,233	290.2	11,139	108,989	50,489	655	77,106
Chemicals & Allied Products	37,264	12,965	1,084.8	11,952	229,546	120,778	1,028	117,442
Rubber & Plastics	12,074	3,897	477.5	8,161	86,634	44,437	863	51,473
Oil refinery	22,043	3,655	170.1	21,488	130,414	18,518	154	120,562
Non-metallic Mineral Products	37,232	16,562	2,741.4	6,041	61,477	33,383	554	60,237
Basic & Fabricated Metal Products	88,090	28,959	2,752.3	10,522	267,614	121,078	2,229	54,322
Machinery & Transport Equipment	185,772	78,751	12,358.5	6,372	550,606	255,264	3,966	64,366
Electrical Machinery & Equipment	19,014	8,443	1,193.2	7,076	171,286	95,815	1,689	56,716
Other Manufacturing Industries	10,516	3,348	538.5	6,210	275,532	178,590	3,008	57,376
Total Manufacturing	708,684	225,350	32,414	6,952	2,475,901	1,165,747	18,950	61,517

Source: Appendix tables A.3 and A.4

Tables 9 and 10 show levels of gross value of output and value added using the definitions as described in appendix A, and unit value ratios as converters (see appendix B) for the six major branches³⁵. In table 9 we see that the gross output level of Soviet manufacturing was little over 60 percent of the US. This is in sharp contrast with the relative size of employment: Soviet manufacturing employed more than 1.7 times as many persons as in the USA.

The leather branch had an exceptionally high level of gross output relative to the USA (112 percent). This is not really surprising since leather and fur products, both included in this branch, are far more popular in Russia than they are in the USA. The non-metallic mineral products branch is another with a high gross output ratio relative to the USA (151 percent). This is mainly due to the high production level of construction materials in the

³⁵ Appendix tables A.3 and A.4 show the same tables on a lower level of aggregation, i.e. for sixteen branches.

Soviet Union. The Soviet value of production of construction materials (excluding glass) in rubles was higher than the production of stone, clay and glass products together in the US valued in dollars. The machinery and transport equipment branch was very important in both the US and the Soviet Union. An explanation for this difference in size is difficult to give since detailed output information for Soviet military industries, which form a substantial part of this branch, is not available. But, the Soviet machinery sector focused more heavily than the USA on producing non-electrical machinery. Compared to the USA the USSR concentrated less on producing consumer electronics, which are part of the electronic machinery branch.

On average 68 percent of Soviet gross output, valued in rubles, was used as intermediate inputs in other industrial activities. Compared to other communist economies which have been studied in the ICOP project we see that in 1989 Czechoslovakia's share of material inputs in output was 73 percent. For East Germany this was 66 percent in 1987³⁶. Compared to US and West German shares of 53 and 58 percent respectively this clearly confirms the general tendency of communist command economies to use inputs less efficiently than market economies. The ratio of Soviet to US value added (43 percent) was considerably lower than that for gross output (61 percent). The Soviet tendency to high intermediate input use was strongest in the light industry branch: food, beverages, tobacco, textiles, apparel and leather.

As explained in appendix A, value added is our preferred concept of output. Tables 11 and 12 show relative labour productivity levels on the basis of value added. National currencies are converted using unit value ratios from table 2. The last column shows the geometric average of the results at Soviet and US prices. Soviet relative level of value added per employee for total manufacturing was 25 percent of the USA. The level for value added per hour worked in the USSR relative to the USA was 26 percent. Soviet relative labour productivity was highest in the metal and machinery branches. The relative high level of productivity in the machinery branch needs to be interpreted with caution since the reliability of its unit value ratio is questionable³⁷.

Tables 7 and 8 give some idea of the distribution of gross output, value added, and employment, between branches, showing percentage shares for 16 branches. The gross output and value added figures in table 7 are weighted at national prices, in table 8 weighted at the other countries prices. Soviet food, metals and machinery branches together accounted for more than 50 percent of total output and employment compared with about 40 percent in the USA. Textiles, wearing apparel and leather contributed more than 15 percent of Soviet output and less than 5 percent in the USA. The biggest outlier was 'other manufacturing' which had a much larger share in the United States. This is because the higher degree of detail in the US statistics made it easier to decide that a particular industry belongs to 'other manufacturing', while in the Soviet Union such a distinction was not always feasible. Graphs 2 and 3 show the distribution of value added for the same 16 branches. The value added in each graph is weighted at both Soviet and US prices. It is clear that Soviet manufacturing was far more heavily concentrated in the machinery and transport equipment branch than was US manufacturing. The graphs also illustrate the differences in outcome when weighted at Soviet or US prices.

³⁶ See van Ark, 1994.

³⁷ See appendix B.

Table 7
Gross Value of Output, Value Added and Number of Persons Engaged
by Manufacturing Branch, USSR/USA, 1987
(percentage of totals in national prices)

	USSR			USA		
	Gross Value of Output	Value Added	Persons Engaged	Gross Value of Output	Value Added	Persons Engaged
Food Manufacturing	18.85	10.80	8.98	11.41	8.49	7.30
Beverages	1.56	0.89	0.96	1.91	1.94	0.91
Tobacco Products	0.67	0.22	0.12	0.84	1.22	0.34
Textile Mill Products	8.84	5.25	6.16	2.54	2.20	3.69
Wearing Apparel	4.67	4.22	7.21	2.59	2.79	5.88
Leather Goods & Footwear	1.86	1.74	2.09	0.37	0.38	0.72
Wood Products, Furniture & Fixtures	4.32	5.98	7.82	4.33	4.20	6.52
Paper Products	1.10	1.43	0.90	4.40	4.33	3.46
Chemicals & Allied Products	5.26	5.75	3.35	9.27	10.36	5.43
Rubber & Plastics	1.70	1.73	1.47	3.50	3.81	4.56
Oil refinery	3.11	1.62	0.52	5.27	1.59	0.81
Non-metallic Mineral Products	5.25	7.35	8.46	2.48	2.86	2.92
Basic & Fabricated Metal Products	12.43	12.85	8.49	10.81	10.39	11.76
Machinery & Transport Equipment	26.21	34.95	38.13	22.24	21.90	20.93
Electrical Machinery & Equipment	2.68	3.75	3.68	6.92	8.22	8.91
Other Manufacturing Industries	1.48	1.48	1.66	11.13	15.32	15.87
Total Manufacturing	100.00	100.00	100.00	100.00	100.00	100.00

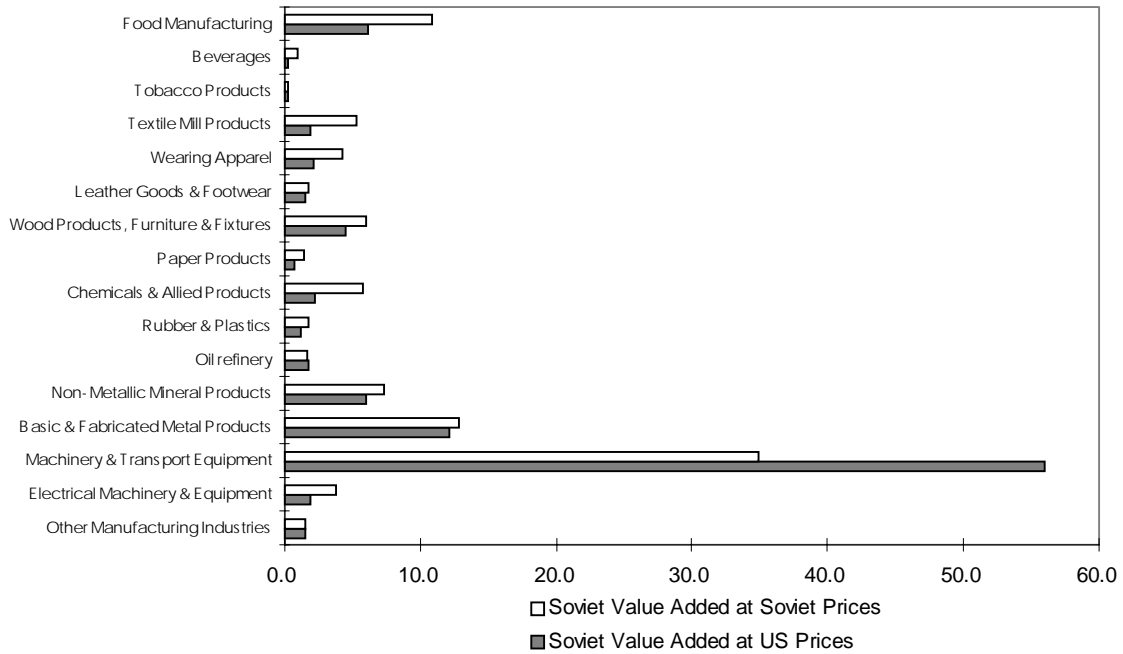
Source: Tables 8 and 9, and appendix tables A.3 and A.4.

Table 8
Gross Value of Output, and Value Added by Manufacturing Branch, USSR/USA, 1987
(percentage of totals in other countries prices)

	USSR		USA	
	Gross Value of Output	Value Added	Gross Value of Output	Value Added
Food Manufacturing	13.27	6.14	15.75	10.89
Beverages	0.57	0.27	2.66	2.81
Tobacco Products	0.73	0.22	0.44	0.63
Textile Mill Products	3.40	1.84	4.43	3.78
Wearing Apparel	2.54	2.09	3.64	3.85
Leather Goods & Footwear	1.78	1.51	0.24	0.25
Wood Products, Furniture & Fixtures	3.47	4.50	4.08	3.88
Paper Products	0.57	0.68	5.80	5.61
Chemicals & Allied Products	2.25	2.29	14.55	16.00
Rubber & Plastics	1.24	1.15	3.36	3.60
Oil refinery	3.71	1.76	2.82	0.84
Non-metallic Mineral Products	4.67	6.05	1.57	1.80
Basic & Fabricated Metal Products	12.70	12.13	7.84	7.42
Machinery & Transport Equipment	45.96	56.01	8.99	8.72
Electrical Machinery & Equipment	1.49	1.89	12.50	14.60
Other Manufacturing Industries	1.63	1.48	11.32	15.32
Total Manufacturing	100.00	100.00	100.00	100.00

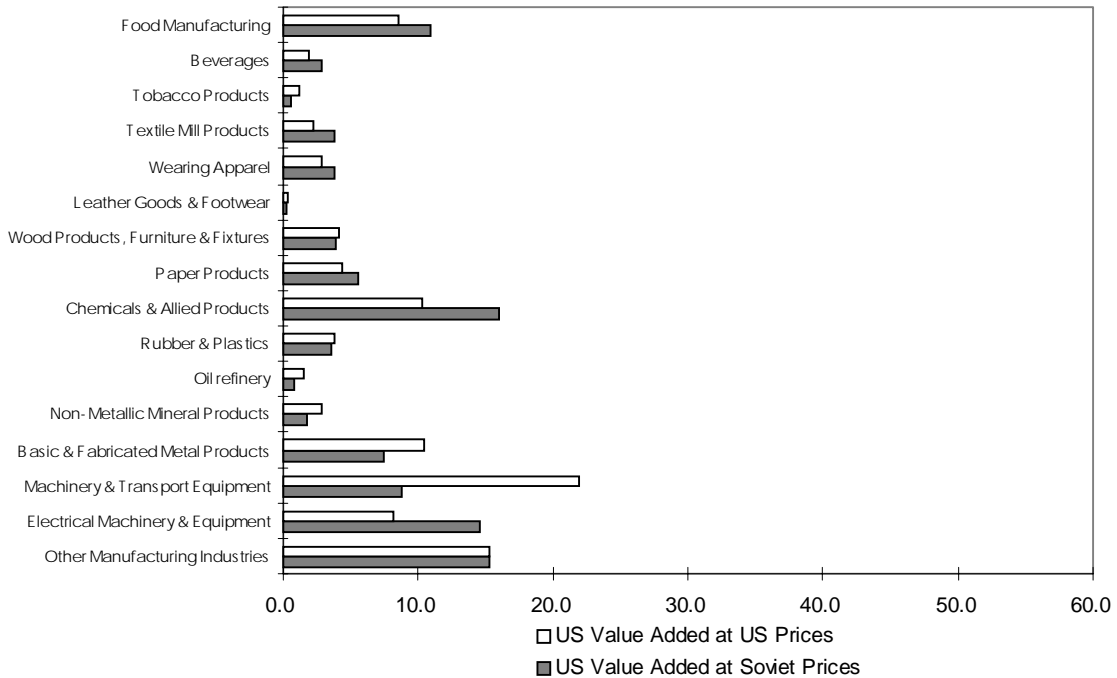
Source: Tables 8 and 9, and appendix tables A.3 and A.4.

Graph 2
Soviet Value Added by Manufacturing Branch, 1987
 (value added of total manufacturing=100)



Source: Tables 7 and 8.

Graph 3
US Value Added by Manufacturing Branch, 1987
 (value added of total manufacturing=100)



Source: Tables 7 and 8.

Table 9
Gross Value of Output by Manufacturing Branch
USSR/USA, 1987

	at Soviet Producer Prices			at US Producer Prices			Geometric average USSR/USA (%)
	USSR	USA	USSR/ USA	USSR	USA	USSR/ USA	
	(in million Rubles)		(%)	(in million US\$)		(%)	
Food Manufacturing	133,556.4	229,772.7	58.1	247,133.5	282,398.2	87.5	71.3
Beverages	11,077.4	38,788.3	28.6	10,555.5	47,327.2	22.3	25.2
Tobacco Products	4,719.3	6,391.4	73.8	13,587.4	20,757.1	65.5	69.5
Textile Mill Products	62,652.7	64,678.8	96.9	63,356.7	62,786.4	100.9	98.9
Wearing Apparel	33,129.2	37,948.5	87.3	47,399.0	64,242.7	73.8	67.8
Leather Goods & Footwear	13,157.5	3,732.3	352.5	33,115.6	9,082.4	364.6	366.8
Wood Products, Furniture & Fixtures	30,582.1	59,455.8	51.4	64,661.8	107,208.6	60.3	55.7
Paper Products	7,809.3	84,559.7	9.2	10,628.0	108,988.7	9.8	9.5
Chemicals & Allied Products	37,263.6	212,319.1	17.6	41,917.1	229,546.1	18.3	17.9
Rubber & Plastics	12,074.2	49,033.0	24.6	23,131.8	86,634.3	26.7	25.6
Oil refinery	22,042.8	41,196.1	53.5	69,146.2	130,414.0	53.0	53.3
Non-metallic Mineral Products	37,231.5	22,976.0	162.0	87,051.1	61,476.6	141.6	151.5
Basic & Fabricated Metal Products	88,089.7	114,453.6	77.0	236,624.4	267,614.3	88.4	82.5
Machinery & Transport Equipment	185,771.8	131,237.9	141.6	855,996.4	550,605.6	155.5	148.3
Electrical Machinery & Equipment	19,013.8	182,323.8	10.4	27,796.6	171,286.4	16.2	13.0
Other Manufacturing Industries	10,515.6	165,087.7	6.4	30,410.2	275,532.4	11.0	8.4
Total Manufacturing	708,686.9	1,459,015.3	48.6	1,862,511.3	2,475,901.0	75.2	60.4

Source: gross value of output from appendix table A.3 and A.4; currencies converted with UVR's from table 4.

Table 10
Value Added by Manufacturing Branch
USSR/USA, 1987

	at Soviet Producer Prices			at US Producer Prices			Geometric average USSR/USA (%)
	USSR	USA	USSR/ USA	USSR	USA	USSR/ USA	
	(in million Rubles)		(%)	(in million US\$)		(%)	
Food Manufacturing	24,328.6	76,031.6	32.0	40,042.4	99,018.1	40.4	36.0
Beverages	1,997.7	19,642.4	10.2	1,765.2	22,584.8	7.8	8.9
Tobacco Products	489.8	4,392.0	11.2	1,410.2	14,263.8	9.9	10.5
Textile Mill Products	11,826.9	26,433.5	44.7	11,959.8	25,660.1	46.6	45.7
Wearing Apparel	9,507.0	26,913.8	35.3	13,602.0	32,515.5	41.8	38.4
Leather Goods & Footwear	3,922.2	1,719.0	228.2	9,871.7	4,377.9	225.5	226.8
Wood Products, Furniture & Fixtures	13,471.6	27,124.7	49.7	29,294.0	48,975.0	59.8	54.5
Paper Products	3,232.6	39,172.1	8.3	4,399.4	50,488.8	8.7	8.5
Chemicals & Allied Products	12,965.3	111,756.8	11.6	14,891.6	120,777.6	12.3	12.0
Rubber & Plastics	3,896.6	25,150.2	15.5	7,465.2	44,436.8	16.8	16.1
Oil refinery	3,655.1	5,849.7	62.5	11,465.7	18,518.3	61.9	62.2
Non-metallic Mineral Products	16,561.6	12,559.6	131.9	39,459.1	33,383.1	118.2	124.8
Basic & Fabricated Metal Products	28,958.6	51,811.4	55.9	79,026.9	121,078.4	65.3	60.4
Machinery & Transport Equipment	78,750.7	60,917.7	129.3	365,031.7	255,263.6	143.0	136.0
Electrical Machinery & Equipment	8,442.7	101,989.5	8.3	12,342.5	95,815.3	12.9	10.3
Other Manufacturing Industries	3,343.8	107,003.6	3.1	9,670.0	178,589.7	5.4	4.1
Total Manufacturing	225,350.9	698,467.7	32.3	651,697.4	1,165,746.8	55.9	42.5

Source: value added from appendix table A.3 and A.4; currencies converted with UVR's from table 4. See section 4 above on the definition of value added in the two countries.

Table 11
Value Added per Person Engaged by Manufacturing Branch
USSR/USA, 1987

	at Soviet Producer Prices			at US Producer Prices			Geometric average USSR/USA
	USSR	USA	USSR/ USA	USSR	USA	USSR/ USA	
	(in Rubles)		(%)	(in US\$)		(%)	
Food Manufacturing	8,360.0	54,929.3	15.2	13,759.8	71,563.0	19.2	17.1
Beverages	6,407.1	113,587.0	5.6	5,661.3	130,302.3	4.3	4.9
Tobacco Products	12,656.7	69,165.5	18.3	36,439.8	224,626.8	16.2	17.2
Textile Mill Products	5,919.7	37,821.6	15.7	5,986.2	36,715.0	16.3	16.0
Wearing Apparel	4,069.6	24,164.0	16.8	5,822.5	29,193.3	19.9	18.3
Leather Goods & Footwear	5,787.3	12,688.0	45.7	14,565.9	32,261.6	45.1	45.4
Wood Products, Furniture & Fixtures	5,314.2	21,961.5	24.2	11,555.8	39,652.7	29.1	26.6
Paper Products	11,139.3	59,823.0	18.6	15,159.9	77,105.7	19.7	19.1
Chemicals & Allied Products	11,951.8	108,670.6	11.0	13,727.5	117,442.2	11.7	11.3
Rubber & Plastics	8,160.5	29,132.6	28.0	15,633.9	51,473.2	30.4	29.2
Oil refinery	21,487.9	38,083.9	56.4	67,405.4	120,561.8	55.9	56.2
Non-metallic Mineral Products	6,041.3	22,662.6	26.7	14,393.8	60,236.6	23.9	25.2
Basic & Fabricated Metal Products	10,521.6	23,245.3	45.3	28,713.2	54,322.0	52.9	48.9
Machinery & Transport Equipment	6,372.2	15,360.7	41.5	29,536.9	64,366.2	45.9	43.6
Electrical Machinery & Equipment	7,075.6	60,370.2	11.7	10,344.0	56,715.6	18.2	14.6
Other Manufacturing Industries	6,209.6	35,575.4	17.5	17,957.7	57,375.5	30.2	23.0
Total Manufacturing	6,952.3	36,857.9	18.9	20,105.6	61,516.0	32.7	24.8

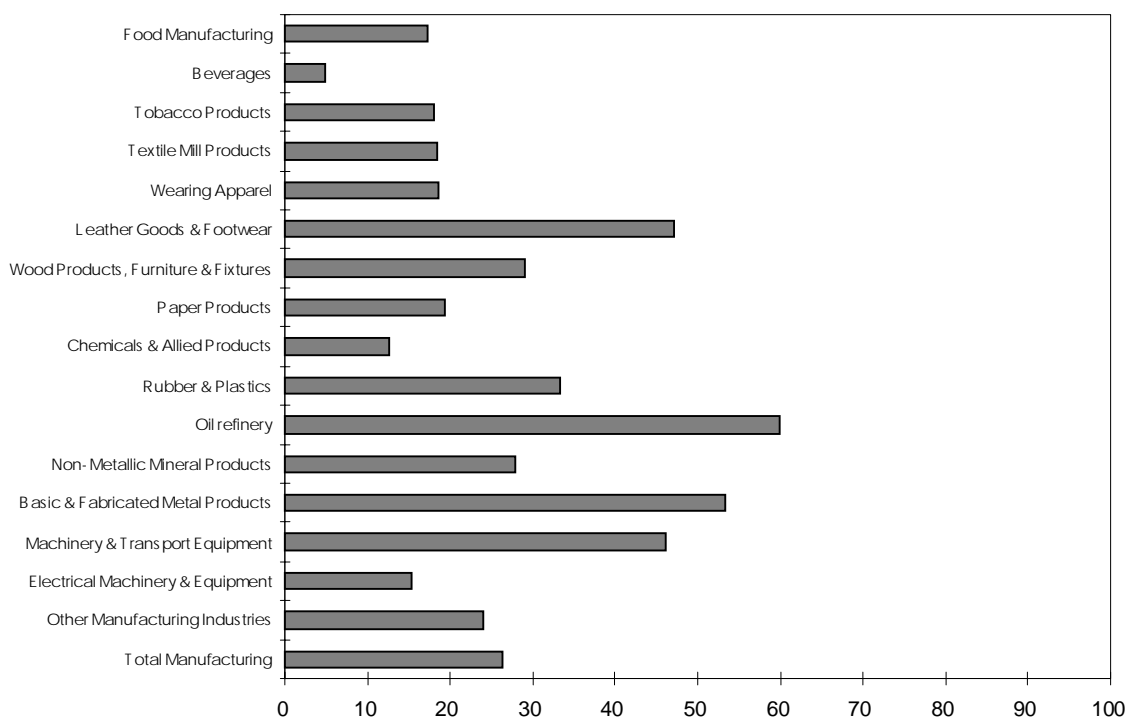
Source: value added and persons engaged from appendix tables A.3 and A.4; currencies converted with UVR's from table 4.

Table 12
Value Added per Hour Worked by Manufacturing Branch
USSR/USA, 1987

	at Soviet Producer Prices			at US Producer Prices			Geometric average USSR/USA
	USSR	USA	USSR/ USA	USSR	USA	USSR/ USA	
	(in Rubles)		(%)	(in US\$)		(%)	
Food Manufacturing	4.5	29.0	15.4	7.4	37.8	19.5	17.3
Beverages	3.4	60.9	5.6	3.0	70.0	4.3	4.9
Tobacco Products	7.1	37.3	19.1	20.5	121.2	16.9	18.0
Textile Mill Products	3.3	18.4	18.1	3.4	17.9	18.9	18.5
Wearing Apparel	2.3	13.5	17.0	3.3	16.3	20.2	18.5
Leather Goods & Footwear	3.3	6.9	47.4	8.2	17.5	46.9	47.2
Wood Products, Furniture & Fixtures	3.0	11.2	26.5	6.4	20.2	31.9	29.1
Paper Products	6.1	32.4	18.9	8.4	41.7	20.0	19.5
Chemicals & Allied Products	6.9	56.5	12.2	7.9	61.1	12.9	12.5
Rubber & Plastics	4.7	14.7	32.0	9.0	25.9	34.7	33.3
Oil refinery	11.9	19.8	60.2	37.4	62.7	59.6	59.9
Non-metallic Mineral Products	3.3	11.3	29.5	8.0	30.1	26.5	28.0
Basic & Fabricated Metal Products	5.9	11.9	49.3	16.0	27.8	57.5	53.2
Machinery & Transport Equipment	3.5	8.1	43.9	16.4	33.8	48.5	46.1
Electrical Machinery & Equipment	3.9	32.2	12.2	5.7	30.2	19.0	15.2
Other Manufacturing Industries	3.4	18.9	18.3	10.0	31.5	31.7	24.0
Total Manufacturing	3.9	19.3	20.0	11.2	32.2	34.6	26.3

Source: value added, persons engaged, and average annual hours worked per person from appendix tables A.3 and A.4; currencies converted with UVR's from table 4.

Graph 4
Soviet Value Added per Hour Worked as Percentage of US,
by Manufacturing Branch, 1987, US=100, Fisher averages



Note: The figures in this table are the geometric averages (or Fisher averages) of the Paasche and Laspeyres averages in table 11.

7 Mining

For comparing Soviet and US mining the same issues apply as mentioned in section 6, i.e. the differences between market and non-market economies regarding prices, quality, classification, and concepts. Table 13 shows comparative levels of output, value added, employment, average annual hours worked and productivity in mining. It is clear that Soviet productivity in mining relative to the US was almost twice as high as in manufacturing. One possible explanation could be the richness of Soviet natural resources, which made it (1) possible to concentrate on easily accessible sources, and (2) benefit from economies of scale. Mining is an activity with a particularly great influence on the environment. Recent discoveries of extensive pollution in the Soviet Union give some clue of how 'dirty' Soviet mining was. This clearly could have had its influence on productivity.

About 48 per cent of both Soviet and US mining output at national prices was produced in the oil and gas extracting industry. Other important mining industries were: coal, iron ore, and mining of chemical raw material. Table 13 shows value added per employee for the three mining industries for which product matches could be made. Crude petroleum and natural gas were clearly the most productive, with a productivity over 50 per cent higher than in the USA. This industry dominates the results for mining as a whole. The oil and gas extraction industry is the biggest sector, and had the highest relative Soviet productivity.

Table 13
Output, Value Added, Persons Engaged
and Productivity in Mining, USSR/USA, 1987

	at Soviet Producer Prices			at US Producer Prices			Geometric average USSR/USA (%)
	USSR	USA	USSR/ USA (%)	USSR	USA	USSR/ USA (%)	
Gross value of output (million currency units)							
Coal	15,662	12,286	127.5	29,145	25,955	112.3	119.7
Iron ore	4,914	1,092	450.1	6,133	1,362	450.1	450.1
Crude petroleum and natural gas	23,891	14,847	160.9	124,995	76,579	163.2	162.0
Other mining*	5,755	14,587	39.5	22,181	54,128	41.0	40.2
Total mining	50,221	42,811	117.3	182,453	158,025	115.5	116.4
Value added (million currency units)							
Coal	8,301	8,079	102.7	15,446	17,068	90.5	96.4
Iron ore	3,073	615	499.5	3,836	768	499.5	499.5
Crude petroleum and natural gas	19,757	13,178	149.9	103,369	67,973	152.1	151.0
Other mining*	2,723	3,331	81.7	10,496	12,361	84.9	83.3
Total mining	33,854	25,204	134.3	130,487	98,170	132.9	133.6
Persons engaged (000s)							
Coal	1,263	163	772.6				
Iron ore	249	7	3,501.4				
Crude petroleum and natural gas	198	201	98.9				
Other mining*	335	329	101.9				
Total mining	2,045	700	292.1				
Annual average hours worked per person in mining (unit)	1,792	2,046	86.9				
Value added per person engaged (currency units)							
Coal	6,575	49,443	13.3	12,235	104,455	11.7	12.5
Iron ore	12,363	86,660	14.3	15,429	108,155	14.3	14.3
Crude petroleum and natural gas	99,632	65,727	151.6	521,275	339,019	153.8	152.7
Other mining*	8,119	10,121	80.2	31,294	37,559	83.3	81.7
Total mining	16,556	36,000	46.0	63,814	140,222	45.5	45.7
Value added per hour worked (currency units)	9.2	17.6	52.5	35.6	68.5	52.0	52.2

* This is a residual after subtracting coal, iron ore, and petroleum and gas from total mining.

Sources: US output, value added and persons engaged from *US Census of Mineral Industries*; US Hours from Pilat, 1993. Soviet output and persons engaged from CIS-STAT files; Value added estimated using share of material inputs in gross output from Soviet 1987 input-output table as provided by CIS-STAT. For estimation of Soviet hours worked see appendix A.3. Currencies converted with UVR's of table 4.

8 Industry as a Whole

Hitherto, this study has focused on a comparison of manufacturing and mining performance. In order to merge the cross-section findings for the benchmark year 1987 with the available time series, it is necessary to round off the 1987 estimates to cover industry as a whole. Table 14 shows gross output, value added, and labour inputs in residual activities considered to be industrial in the Soviet classification. In order to ensure consistency with US definitions we took account only of Soviet electricity and fibre processing. I excluded fishing and industrial repair and maintenance as these are not considered to be industrial activities in the USA, and are excluded from the CIA time series.

Table 15 shows the comparative results for Soviet and US industry and the three components: manufacturing, mining, and electricity and fibre processing. For manufacturing and mining I made detailed estimates of UVRs to convert figures to dollars. For the rest group, I simply used a weighted average of the UVRs for manufacturing and mining.

Table 14
Gross Output, Value Added, Persons Engaged and Hours Worked
in Residual Industrial Activities, USSR, 1987

	Gross Output (million rubles)	Value Added (million rubles)	Persons Engaged	Assumed Annual Hours Worked
Electricity	30,769	14,677	874,900	1,784
Fibre Processing	12,245	2,057	135,400	1,784
Fishing	4,573	2,081	157,700	1,784
Industrial Repair and Maintenance (a)	25,460	13,205	3,071,500	1,784

(a) includes shoe and fur repair.

Sources: Soviet gross output and persons engaged from CIS-STAT files. Value added (MPS concept) derived by deducting inputs as shown in partial input-output table for industry as supplied to the author by CIS-STAT. Annual working hours assumed to be the same as Heleniak (1990) estimated for total industry.

Table 15
Value Added, Persons Engaged and Productivity in Soviet and US Industry, 1987

	Value Added at Soviet Producer prices (million rubles)		Value Added at US Producer prices (million dollars)	
	USSR	USA	USSR	USA
Manufacturing	225,350	698,466	651,697	1,165,747
Mining	33,854	25,204	130,487	98,170
Electricity and fibre processing	16,734	79,934	50,556	139,500
Industry (US definition)	275,938	803,604	832,740	1,403,417
	Persons Engaged (000s)		Average Annual Hours Worked per Person Engaged	
	USSR	USA	USSR	USA
Manufacturing	32,414	18,950	1,801	1,909
Mining	2,045	700	1,792	2,046
Electricity and fibre processing	1,010	921	1,834	1,890
Industry (US definition)	35,469	20,571	1,783	1,828
	Value Added per Person Engaged at Soviet Producer prices (rubles)		Value Added per Person Engaged at US Producer prices (dollars)	
	USSR	USA	USSR	USA
Manufacturing	6,952	36,858	20,106	61,516
Mining	16,556	36,000	63,814	140,222
Electricity and fibre processing	16,568	86,790	50,055	151,466
Industry (US definition)	7,780	39,064	23,478	68,222
	Value Added per Hour Worked at Soviet Producer prices (rubles)		Value Added per Hour Worked at US Producer prices (dollars)	
	USSR	USA	USSR	USA
Manufacturing	3.9	19.3	11.2	34.6
Mining	9.2	17.6	35.6	52.0
Electricity and fibre processing	9.0	45.9	27.3	34.0
Industry (US definition)	4.4	21.4	13.2	35.3

Source: Derived from tables 10 through 14; US utilities from table 21. The UVR's for industry were .331 rubles per dollar with Soviet weights (Paasche converter); .573 at US quantity weights (Laspeyres converter). These were derived as described in the text.

A Crosscheck on my Results for Industry as a Whole

As a crosscheck on my ICOP approach, I made a sensitivity test by replicating Schroeder's (1964) use of the physical quantity method, and applied it to my data set. This provides a test to see the differences in results compared to my method. I was able to replicate the Schroeder method for 15 of her 25 industries for 1987 (see table 16). Average physical output per employee was derived using both Soviet and US employment weights. Value added per employee was averaged over the industries using value added weights. For these industries Soviet productivity was on average higher relative to the USA using her physical quantity method than my value added method, but there was substantial variation across industries. Soviet physical output per employee for the 15 industries averaged 33

per cent of the USA (using both Soviet and US employment weights), whereas the ICOP method showed average Soviet productivity to be 23 per cent of the USA.

Table 16
A Confrontation of the Physical Output Method and the ICOP Approach
Physical Output per Employee and Value Added per Employee in 15 Industries,
USSR/USA, 1987

	Quantity unit	Soviet as per cent of US		Difference between the two methods
		Productivity		
		Physical Output per Employee	Value Added per Employee	
Coal	thousand tons	10	13	-3
Iron ore	thousand tons	11	14	-3
Petroleum refining	million litres	16	36	-20
Blast furnace and steel works	thousand tons	57	43	14
Steel pipes	thousand tons	63	54	9
Electrometallurgical products	thousand tons	77	74	3
Cement	thousand tons	34	25	9
Lime and gypsum	thousand tons	29	38	-9
Brick and tile	thousand tons	9	12	-3
Chemical fibres	thousand tons	17	12	5
Synthetic rubber	thousand tons	9	21	-12
Paper	thousand tons	15	13	2
Meat	thousand tons	29	25	4
Dairy	thousand tons	84	14	70
Sugar	thousand tons	24	11	13
Average		33	23	10

Source: Physical output from annex; value added and employment from table 11.

9 Merger of the 1987 Benchmark Estimates with Time Series for 1928-90

To get a view on the dynamics of comparative productivity, I merged time series for both countries with my benchmark estimates for 1987.

Soviet time series

Extensive work on Soviet value added time series from 1950 onwards has been carried out by the US Central Intelligence Agency (CIA). The results of this work were published in studies of the Joint Economic Committee of the US Congress (JEC 1982, and 1990). These were mainly based on physical output indicators with value added weights at 1982 factor prices, though a proportion of the estimates was derived from official deflated value series. CIA (1991) provides an update of JEC (1982 and 1990). I rebased these time series on my 1987 benchmark at 1987 prices. The CIA estimates are based on the official Soviet classification, and I had to reclassify the estimates to arrive at separate time series for manufacturing, mining and utilities (see table 19)³⁸.

For the period before 1950 I relied on Moorsteen and Powell (1966)³⁹, who show civilian industries and munitions industries separately. These I aggregated using 1937 value added weights. Their value added series refer to the territory of the USSR in the year specified.

³⁸ Column 1 of table 19 shows the 1950-90 series for Soviet industry as they appear in (CIA, 1991b). These series are valued at factor cost and in 1982 rubles. The first adjustment excludes the extraction of energy sources such as oil, and coal. Due to differences in detail between CIA, 1991a and CIA, 1991b, first all fuel (CIA, 1991b) was deducted from the industry series (column 2) and then oil refinery series were added back in (CIA, 1991a) (column 7). Column 3 deducts electric power from the series (CIA, 1991b). Column 4 deducts the mining activities of the ferrous metals branch (CIA, 1991a). Column 5 deducts logging (CIA, 1991a). Finally column 6 deducts machinery repair activities (CIA, 1991a).

³⁹ Value added from Moorsteen and Powell, 1966, table P-1, pp. 662-4; employment from Powell, 1963, table IV.11, p. 188.

Their pre-1940 figures have been adjusted for frontier changes⁴⁰. Soviet pre-war employment series are from Powell (1963, p. 88). Post-war Soviet employment is from Heleniak (1990). His figures were taken from various issues of *Narodnoe Khozyaistvo*. Average annual hours worked per person are from Heleniak (1990) and Rapawy and Kingkade (1988). The hours were derived by them from various issues of *Vestnik Statistiki*. For years where *Vestnik Statistiki* did not provide figures the series were estimated by the movement of output and productivity as given in various issues of *Narodnoe Khozyaistvo*. The resulting time series are shown in table 20.

US time series

The US series are for the manufacturing, mining, and utilities sectors (see table 21). Value added in 1929 dollars, and labour inputs for 1917-1950 are from Kendrick (1961). The figures from 1950 onwards are from various issues of the Survey of Current Business of the Bureau of Economic Analysis (see source notes on table 21). Estimates for average annual hours worked are from Pilat (1993).

The relative levels of industrial productivity of the two countries can be seen in table 23. This table links the time series for Soviet and US value added per hour worked in industry to the 1987 benchmark level from table 15 above. Due to lack of Soviet series for employment and hours worked per person for manufacturing, mining, and utilities, the industry series could not be disaggregated

The time series from table 20 and 21 are summarised in table 17 below.

Table 17
Provisional Summary Comparison, Industry, USSR/USA, 1928-90

	Soviet Industrial Value Added (million 1987 rubles)	Total Hours Worked in Soviet Industry (million)	Soviet Value Added per Hour Worked (1987 rubles)	US Industrial Value Added (million 1987 dollars)	Total Hours Worked in US Industry (million)	US Value Added per Hour Worked (1987 dollars)
1928	10,753	11,702	0.9	113,630		
1950	39,932	30,740	1.3	368,734	33,445	11.0
1973	187,867	55,399	3.4	917,181	42,008	21.8
1987	275,938	63,277	4.4	1,100,300	40,466	27.2
1990	273,629	58,937	4.6	1,165,300	41,189	28.3

Source: tables 20 and 21.

⁴⁰ In accordance with Maddison (1995, p. 232) I applied a ratio of 1.118 to adjust their figures for 1928-39 to a post-war basis. This ratio is based on the increase in population as a result of the territorial gains in 1940. For a discussion of the impact of frontier changes see Lorimer (1946).

10 Firm Size

So far this paper has concentrated on estimating output and productivity in the Soviet Union relative to the United States. Nothing has been said to explain the differences we found. Here I take a first step in the direction of an analysis of these differences by looking at firm size.

In her 1985 study Eva Ehrlich investigated the size structure of establishments and enterprises⁴¹ in both capitalist and socialist countries (Ehrlich, 1985). She concluded that the size of establishments was considerably larger in socialist countries than in capitalist countries. For this fact she suggested several explanations (Ehrlich, 1985, pp. 293-294).

(1) In the socialist political system, private ownership was liquidated and small-scale craft industries were suppressed.

(2) Because Soviet-type industrialisation aimed at rapid economic development and elimination of unemployment, masses of new industrial jobs were created. Planners gave priority to iron and steel and investment goods which usually involve large enterprises.

(3) Socialist economies tried to economise on the use of intellectual labour by creating large enterprises with one centralised management.

(4) A system of central planning cannot function in an environment of small-scale, autonomous units. The command economies were easier to handle if they consisted of relatively few, large scale enterprises.

In table 18 below, one can see that her general conclusions about firm size in socialist economies also applied to the Soviet Union in 1987. In the USSR almost three-quarters of the persons engaged worked in *enterprises* with more than one thousand employees. In the USA the same share of employees worked in *establishments* with less than one thousand employees. More than 90 per cent of US *establishments* had less than 100 employees, while this was true for less than 30 per cent of Soviet *enterprises*. In the last line of the table one can see that the average number of employees in a Soviet *enterprise* was 814, and 50 in an average US *establishment*.

The above conclusions have to be drawn with some care. In the US some enterprises e.g. General Motors have several hundred establishments and there are a very large number of firms with more than one plant. For this reason we are endeavouring to find out how many enterprises there were in the US in 1987. From the Japanese Establishment Census we know for instance that in 1991 Japan had 857,016 establishments, and 337,578 enterprises (a ratio of 2.54)⁴². The number of Soviet units would certainly be increased if we had been able to use establishment rather than enterprise data.

⁴¹ An establishment is a local production unit characterised by its geographical location. An enterprise is a legal unit that can consist of more than one establishment.

⁴² Supplied by Dirk Pilat from *Japan Statistical Yearbook*, 1993/94, Statistical Bureau, Management and Coordination Agency, Tokyo, pp. 174-189.

Table 18
Number of Enterprises/Establishments, Employees, and Number of Employees per
Enterprise/Establishment, USSR and USA, 1987*

	Number of Enterprises/Establishments*			
	USSR	%	USA	%
Enterprises/Establishments* with an average of				
1-100 employees	12,740	27.2	324,165	90.3
101-500 employees	20,282	43.3	29,858	8.3
501-1,000 employees	6,136	13.1	3,211	0.9
1,001 and more employees	7,682	16.4	1,711	0.5
Total	46,840	100.0	385,945	100.0
	Number of Employees (000s)			
	USSR	%	USA	%
Enterprises/Establishments* with an average of				
1-100 employees	648	1.7	5,227	29.5
101-500 employees	5,034	13.2	6,110	34.5
501-1,000 employees	4,462	11.7	2,181	12.3
1,001 and more employees	27,994	73.4	4,200	23.7
Total	38,139	100.0	17,717	100.0
	Employees per Enterprise/Establishment*			
	USSR		USA	
Enterprises/Establishments* with an average of				
1-100 employees	50.9		16.1	
101-500 employees	248.2		204.6	
501-1,000 employees	727.2		679.2	
1,001 and more employees	3,644.2		2,454.5	
Total	814.2		49.4	

* Soviet figures are for industrial enterprises, while US figures are for manufacturing establishments.

Sources: Soviet number of enterprises and distribution of employees by size from *Promyshlennost'*, 1989, pp. 13 and 14; Soviet number of employees from *Narodnoe Khozyaistvo 1987*, p. 92; US number of establishments, employment, and distribution of employees by size of establishment from *Census of Manufactures 1987*, General Summary, p. 1-99.

11 Conclusions

This paper set out to study the economic performance of Soviet industry in a long run comparative perspective. Economic performance was estimated by measuring labour productivity, or value added per hour worked. The comparative perspective was used to assess the gap between Soviet economic performance and that of the world productivity leader, i.e. the USA. It appears that in 1987, Soviet value added per hour worked was 26.8 per cent of US productivity. Normally one would expect such a gap to be an indicator of substantial opportunity for catch-up, but throughout the post-war period, Soviet productivity increased only slightly relative to the USA, from 19.7 per cent in 1950 to 27.5 per cent in 1990. Within this period, 1980 was the peak when Soviet productivity was 29.7 per cent of that in the USA. From 1980 onwards, there was a steady deterioration in the relative standing of Soviet productivity. For the pre-war period we cannot draw very clear conclusions, because the available data show large swings in relative labour productivity.

Lenin's priorities left their mark on the Soviet economy even more than 60 years after his death. Soviet industry was heavily concentrated in heavy industry. In 1987, more than two thirds of Soviet industrial value added was produced in iron and steel, and machinery when valued at US prices, and nearly half at Soviet prices. The economic activities of Soviet industry were concentrated in huge enterprises because this facilitated central command, and was thought to lead to economies of scale. Lenin's goal of overtaking the US economy was never achieved.

This study has benefited from co-operation with experts in both Russia and the USA. However, several important questions remain unanswered. (1) Due to differences in statistical concepts between the two countries (MPS versus SNA), it is likely that the differing value added concepts lead to some understatement of relative Soviet productivity

levels. (2) Although I received very favourable treatment from the Russian authorities in access to data, there are still some serious limitations on the quality of the exercise as the full detail of the industrial census is still confidential.

Table 19
Disaggregation of the CIA Industry Series, USSR, 1950-90, with Conversion to my 1987 Benchmark
(million rubles)

Total Soviet Industry at 1982 factor cost	Deduct Fuel	Deduct Electric power	Deduct Ferrous Metal Ores	Deduct Logging	Deduct Machinery Repair	Add back Oil refining	Soviet Manufacturing at 1982 factor cost	Soviet Manufacturing adjusted to 1987 factor cost	Soviet Mining adjusted to 1987 factor cost	Soviet Utilities adjusted to 1987 factor cost	Public	Total Soviet Industry adjusted to 1987 factor cost *
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)		(12)
1950	34.297	3.218	1.011	499	2.858	772	316	26.255	33.561	5.759	951	40.271
1951	38.592	3.523	1.150	575	3.246	864	354	29.587	37.821	6.340	1.082	45.243
1952	41.694	3.779	1.316	660	3.229	967	396	32.139	41.083	6.845	1.238	49.166
1953	45.012	4.046	1.485	737	3.175	1.084	443	34.929	44.649	7.347	1.397	53.394
1954	49.178	4.463	1.660	781	3.614	1.213	501	37.949	48.509	8.031	1.562	58.102
1955	54.278	5.119	1.871	859	3.707	1.358	559	41.923	53.589	9.176	1.761	64.525
1956	57.909	5.557	2.108	926	3.857	1.520	679	44.620	57.038	9.827	1.984	68.848
1957	61.530	6.221	2.309	994	4.111	1.703	782	46.974	60.046	10.893	2.173	73.112
1958	66.147	6.664	2.592	1.045	4.314	1.906	864	50.490	64.540	11.591	2.439	78.570
1959	71.964	7.143	2.913	1.101	4.625	2.154	966	54.994	70.298	12.324	2.741	85.363
1960	77.267	7.565	3.212	1.229	4.422	2.396	1.074	59.517	76.080	13.071	3.022	92.173
1961	82.874	7.952	3.601	1.347	4.307	2.649	1.164	64.182	82.043	13.773	3.388	99.205
1962	89.096	8.479	4.063	1.463	4.337	3.012	1.309	69.051	88.267	14.617	3.823	106.707
1963	93.323	9.125	4.519	1.563	4.538	3.355	1.443	71.666	91.610	15.654	4.252	111.516
1964	99.508	9.702	5.024	1.659	4.714	3.774	1.527	76.162	97.357	16.651	4.727	118.735
1965	105.643	10.223	5.529	1.750	4.676	4.117	1.630	80.978	103.513	17.513	5.203	126.228
1966	111.407	10.909	5.951	1.820	4.622	4.405	1.757	85.457	109.238	18.578	5.600	133.416
1967	119.673	11.535	6.409	1.880	4.839	4.817	1.916	92.108	117.740	19.471	6.031	143.242
1968	126.798	11.980	6.972	1.942	4.861	5.270	2.051	97.824	125.047	20.100	6.560	151.708
1969	132.869	12.533	7.524	2.034	4.796	5.805	2.184	102.362	130.847	20.967	7.080	158.894
1970	139.677	13.056	8.099	2.152	4.966	6.423	2.385	107.365	137.243	21.713	7.621	166.577
1971	145.627	13.715	8.757	2.224	4.963	7.065	2.534	111.437	142.449	22.697	8.240	173.386
1972	151.681	14.476	9.379	2.291	4.948	7.643	2.741	115.686	147.879	23.748	8.825	180.452
1973	161.357	15.236	10.013	2.383	5.043	8.286	2.950	123.347	157.672	24.837	9.422	191.931
1974	172.611	16.044	10.682	2.465	5.029	8.992	3.169	132.568	169.459	25.975	10.051	205.485
1975	182.172	16.754	11.386	2.574	5.172	9.763	3.344	139.867	178.789	27.065	10.714	216.568
1976	187.722	17.377	12.172	2.641	4.992	10.469	3.436	143.506	183.442	28.077	11.453	222.973
1977	193.741	18.079	12.607	2.648	4.901	11.176	3.623	147.953	189.126	28.960	11.863	229.949
1978	197.584	18.667	13.194	2.705	4.707	11.818	3.841	150.334	192.170	29.684	12.415	234.268
1979	201.578	19.111	13.581	2.699	4.540	12.332	3.982	153.296	195.956	30.188	12.779	238.923
1980	204.482	19.435	14.190	2.712	4.593	13.103	4.043	154.492	197.484	30.654	13.352	241.491
1981	207.159	19.657	14.463	2.670	4.590	13.681	4.133	156.232	199.709	30.805	13.609	244.123
1982	209.330	19.972	14.834	2.711	4.523	14.387	4.234	157.136	200.864	31.239	13.958	246.061
1983	214.635	20.183	15.307	2.721	4.563	15.287	4.270	160.845	205.606	31.550	14.403	251.559
1984	219.839	20.263	16.022	2.747	4.671	16.057	4.215	164.294	210.015	31.823	15.076	256.914
1985	224.581	20.240	16.494	2.746	4.656	16.828	4.081	167.699	214.367	32.009	15.520	261.896
1986	230.069	20.905	17.079	2.748	4.884	17.535	4.056	170.974	218.553	33.182	16.071	267.806
1987	237.000	21.297	17.784	2.760	5.003	17.927	4.063	176.292	225.351	33.854	16.734	275.939
1988	243.289	21.594	18.213	2.739	5.022	18.450	4.047	181.317	231.774	34.350	17.138	283.262
1989	241.865	21.241	18.390	2.654	4.834	18.954	3.999	179.792	229.825	33.688	17.304	280.817
1990	235.017	20.388	18.454	2.564	4.399	18.575	3.755	174.392	222.923	32.505	17.364	272.792
Annual Average Compound Growth Rates												
1950-90	4,93	4,72	7,53	4,17	1,08	8,28	6,38	4,85	4,85	4,42	7,53	4,90
1950-73	6,96	6,99	10,48	7,03	2,50	10,87	10,20	6,96	6,96	6,56	10,48	7,02
1973-90	2,24	1,73	3,66	0,43	-0,80	4,86	1,43	2,06	2,06	1,60	3,66	2,09

* There is a discrepancy between col (12), which is the sum of cols (9), (10), and (11), and col (5) of table 20, which is the industry benchmark value added linked to the Moorsteen/Powell/CIA time series. For 1950 this discrepancy amounts to .8 per cent.

Sources: columns (1), (2) and (3) from CIA (1991b); cols (4) through (7) from CIA (1991a); col (8) is col (1) minus cols (2), (3), (4), (5), and (6), plus col (7); col (9) is col (7) adjusted to 1987 rubles from table 9; col (10) is the result of col (2) plus col (4) minus col (7), and adjusted to 1987 rubles from table 12; col (11) is col (3) adjusted to 1987 rubles from table 14.

Table 20
Employment, Working Hours, Gross Value Added,
and Labour Productivity in Soviet Industry, 1928-90

	Employment (000s)	Annual Average Hours Worked per Person	Total Hours Worked (millions)	Value Added at Factor Cost (million 1982 rubles)	Value Added adjusted to new 1987 benchmark (million 1987 rubles)	Labour Productivity Value Added per Hour Worked (1987 rubles)
	(1)	(2)	(3)	(4)	(5)	(6)
1928	5.966	1.961	11.702	9.236	10.753	0.92
1929	6.463	1.918	12.398	10.668	12.420	1.00
1930	7.478	1.875	14.021	12.715	14.804	1.06
1931	8.690	1.832	15.919	13.649	15.891	1.00
1932	9.613	1.788	17.184	14.173	16.502	0.96
1933	8.886	1.794	15.940	15.114	17.597	1.10
1934	9.659	1.803	17.416	17.409	20.269	1.16
1935	10.629	1.811	19.250	20.456	23.816	1.24
1936	11.136	1.819	20.262	23.864	27.784	1.37
1937	11.540	1.827	21.084	24.674	28.728	1.36
1938	12.117	1.827	22.139	25.887	30.141	1.36
1939	12.233	1.827	22.349	27.794	32.360	1.45
1940	11.251	2.230	25.090	26.248	30.561	1.22
1945	9.672	2.398	23.196	18.154	21.137	0.91
1946	10.425	2.153	22.442	18.378	21.397	0.95
1947	11.148	2.148	23.951	20.970	24.415	1.02
1948	12.283	2.149	26.403	25.568	29.768	1.13
1949	13.006	2.161	28.100	30.256	35.226	1.25
1950	14.245	2.158	30.740	34.297	39.932	1.30
1951	15.094	2.152	32.482	38.592	44.932	1.38
1952	15.692	2.146	33.675	41.694	48.544	1.44
1953	16.384	2.142	35.094	45.012	52.407	1.49
1954	17.204	2.139	36.799	49.178	57.258	1.56
1955	17.655	2.135	37.693	54.278	63.196	1.68
1956	18.323	2.082	38.148	57.909	67.423	1.77
1957	18.932	2.033	38.488	61.530	71.639	1.86
1958	19.527	2.019	39.425	66.147	77.015	1.95
1959	20.153	1.964	39.580	71.964	83.787	2.12
1960	21.036	1.890	39.759	77.267	89.962	2.26
1961	22.150	1.808	40.047	82.874	96.490	2.41
1962	22.949	1.808	41.493	89.096	103.734	2.50
1963	23.661	1.804	42.684	93.323	108.656	2.55
1964	24.475	1.813	44.372	99.508	115.857	2.61
1965	25.526	1.799	45.920	105.643	123.000	2.68
1966	26.518	1.808	47.944	111.407	129.711	2.71
1967	27.386	1.813	49.652	119.673	139.335	2.81
1968	28.298	1.817	51.417	126.798	147.630	2.87
1969	28.978	1.821	52.768	132.869	154.699	2.93
1970	29.381	1.817	53.386	139.677	162.625	3.05
1971	29.788	1.828	54.452	145.627	169.553	3.11
1972	30.189	1.824	55.064	151.681	176.601	3.21
1973	30.574	1.812	55.399	161.357	187.867	3.39
1974	31.092	1.816	56.464	172.611	200.970	3.56
1975	31.670	1.813	57.418	182.172	212.102	3.69
1976	32.378	1.812	58.668	187.722	218.564	3.73
1977	32.938	1.808	59.551	193.741	225.572	3.79
1978	33.493	1.800	60.287	197.584	230.046	3.82
1979	33.941	1.796	60.958	201.578	234.696	3.85
1980	34.308	1.791	61.446	204.482	238.077	3.87
1981	34.629	1.786	61.848	207.159	241.194	3.90
1982	34.977	1.782	62.329	209.330	243.722	3.91
1983	35.182	1.780	62.623	214.635	249.899	3.99
1984	35.300	1.782	62.904	219.839	255.958	4.07
1985	35.436	1.783	63.182	224.581	261.479	4.14
1986	35.547	1.785	63.452	230.069	267.868	4.22
1987	35.469	1.784	63.277	237.000	275.938	4.36
1988	34.759	1.790	62.219	243.289	283.260	4.55
1989	33.865	1.796	60.821	241.865	281.602	4.63
1990	32.816	1.796	58.937	235.017	273.629	4.64

Sources: Employment 1928-50 from Powell (1963, p. 188), linked to 1950-89 from Heleniak (1990), 1989-90 from *Narodnoe Khozyaistvo*, 1990, p. 100. This source showed a figure of 38,139 for 1987. Our figure as shown in table 14 is 35,469. We adjusted the Powell-Heleniak employment series for this discrepancy in level. Average hours worked per person 1928-49 from Powell (1963, p. 188); 1950-89 from Heleniak (1990), for 1990 I assumed that average hours worked were the same as for 1989. Value added 1928-50 from Moorsteen and Powell (1966, p. 622) linked to 1950-90 from CIA (1991b). Value added in col 5 links the movement shown in col 4 to our benchmark figure in 1987 rubles from table 3. To account for frontier changes, all 1928-39 figures, except annual average hours worked per person, were adjusted to a post-war basis by multiplying them with the ratio of 1.118. This ratio reflects the population increase due to the territorial gains of 1940 (Maddison, 1995, p.232). Col 6 is col (5) divided by col (3) .

Table 21
Value Added, Labour Inputs, and Productivity in US Industry, National Accounts Concepts, 1917-90

Year	Gross Value Added (national accounts) (million 1987 dollars)			Persons Engaged (000s)			Average Annual Hours Worked per Person			Total Hours Worked (millions)			Value Added per Hour Worked (1987 dollars)			
	manufacturing	public utilities	industry	mining	public utilities	industry	manufacturing	mining	public utilities	mining	public utilities	industry	manufacturing	mining	public utilities	industry
1970	582,164	89,024	763,822	19,689	643	21,023	1,883	2,043	1,932	37,076	1,313	1,336	39,726	15.7	67.8	69.3
1971	592,151	87,590	778,898	18,837	631	20,170	1,884	2,018	1,929	35,491	1,273	1,356	38,120	16.7	68.8	73.1
1972	644,721	86,933	835,635	19,304	639	20,661	1,930	2,032	1,911	37,248	1,298	1,372	39,917	17.3	68.5	74.5
1973	713,661	88,238	917,181	20,380	655	21,770	1,927	2,031	1,918	39,266	1,330	1,411	42,008	18.2	66.3	81.7
1974	679,599	86,209	884,238	20,362	716	21,823	1,866	2,059	1,902	38,407	1,474	1,417	41,298	17.7	58.5	71.4
1975	628,945	83,092	836,126	18,635	770	20,139	1,858	2,019	1,895	34,619	1,565	1,391	37,564	18.2	53.4	89.2
1976	689,938	82,281	895,060	19,351	807	20,895	1,887	2,018	1,878	36,511	1,629	1,384	39,524	18.9	50.5	88.8
1977	740,994	83,500	948,194	20,088	848	21,687	1,895	2,051	1,881	38,063	1,740	1,412	41,215	19.5	48.0	87.6
1978	772,572	85,000	980,772	20,974	904	22,658	1,896	2,048	1,899	39,765	1,852	1,481	43,098	19.4	45.9	83.2
1979	776,569	71,900	971,569	21,503	977	23,289	1,863	2,044	1,893	40,485	1,988	1,529	44,012	19.2	36.0	80.5
1980	724,905	79,900	926,405	20,774	1,069	22,670	1,858	2,068	1,898	38,591	2,233	1,568	42,391	18.8	35.8	77.6
1981	746,190	74,200	942,290	20,674	1,188	22,715	1,862	2,135	1,886	38,503	2,536	1,611	42,649	19.4	29.3	75.7
1982	710,614	73,100	898,614	19,284	1,169	21,327	1,818	2,058	1,880	35,058	2,405	1,643	39,106	20.3	30.4	69.9
1983	733,299	71,300	921,399	18,911	988	20,779	1,881	2,027	1,899	35,574	2,003	1,671	39,249	20.6	35.6	69.9
1984	780,859	82,000	124,700	19,864	999	21,755	1,909	2,081	1,901	37,912	2,080	1,696	41,687	20.9	39.4	73.5
1985	809,946	83,300	1,021,846	19,676	948	21,532	1,905	2,090	1,922	37,474	1,982	1,745	41,201	21.6	42.0	74.8
1986	816,541	83,000	1,026,041	19,441	801	21,156	1,902	2,027	1,892	36,983	1,824	1,729	40,336	22.1	51.1	73.2
1987	877,800	83,000	1,100,300	19,487	745	21,153	1,909	2,046	1,890	37,201	1,524	1,741	40,466	23.6	54.5	80.1
1988	924,600	94,400	1,165,300	19,915	747	21,591	1,935	2,032	1,832	38,532	1,518	1,702	41,752	24.0	62.2	86.0
1989	932,400	83,700	1,168,700	19,965	715	21,618	1,929	2,091	1,904	38,520	1,485	1,786	41,801	24.2	56.0	85.4
1990	922,800	87,700	1,165,300	19,710	738	21,398	1,918	2,156	1,899	37,794	1,591	1,804	41,189	24.4	55.1	85.8

Source: Value added 1917-47 from Kendrick, 1961, 1947-77 supplied by US Department of Commerce, Bureau of Economic Analysis, printout, 1987, 1977-90 from BEA, Survey of Current Business, May 1993; employment 1917-29 from Kendrick, 1961, 1929-48 from National Income and Product Accounts, 1929-58, table 6.4A, 1948-1987 from NIPA, 1929-58, table 6.4B-6.4C, 1987-90 from Survey of Current Business, January, 1992. For 1929-90 full-time and part-time employees were added to the number of self-employed persons, for public utilities it was assumed that the number of self-employed person was nil; average annual hours worked 1917-50 is total hours worked divided by employment, 1950-90 from Pilat (1993); total hours worked 1917-50 product of employment and average annual hours worked.

Table 22
Gross Value Added, Soviet and US Industry, 1950-90

	Gross Value Added at USSR Prices		Gross Value Added at US Prices		Gross Value Added USSR/USA, USA=100		
	USSR (million rubles)	USA	USSR (million dollars)	USA	at Soviet quantity weights	at US quantity weights	geometric average
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1950	39.932	269.305,5	120.508,4	470.315	14,8	25,6	19,5
1951	44.932	301.758,4	135.599,6	526.991	14,9	25,7	19,6
1952	48.544	311.844,9	146.499,0	544.606	15,6	26,9	20,5
1953	52.407	333.188,5	158.157,4	581.881	15,7	27,2	20,7
1954	57.258	315.495,3	172.795,3	550.981	18,1	31,4	23,9
1955	63.196	347.030,1	190.715,1	606.053	18,2	31,5	23,9
1956	67.423	353.846,4	203.473,2	617.958	19,1	32,9	25,0
1957	71.639	357.280,0	216.196,2	623.954	20,1	34,6	26,4
1958	77.015	330.891,3	232.418,8	577.869	23,3	40,2	30,6
1959	83.787	365.408,7	252.857,9	638.150	22,9	39,6	30,1
1960	89.962	368.713,9	271.490,9	643.922	24,4	42,2	32,1
1961	96.490	372.023,3	291.192,0	649.702	25,9	44,8	34,1
1962	103.734	399.554,3	313.054,1	697.782	26,0	44,9	34,1
1963	108.656	428.247,3	327.906,4	747.891	25,4	43,8	33,4
1964	115.857	456.538,4	349.638,4	797.299	25,4	43,9	33,4
1965	123.000	491.637,2	371.194,8	858.595	25,0	43,2	32,9
1966	129.711	527.226,6	391.447,6	920.749	24,6	42,5	32,3
1967	139.335	531.245,9	420.491,6	927.768	26,2	45,3	34,5
1968	147.630	560.182,9	445.526,5	978.304	26,4	45,5	34,6
1969	154.699	578.501,4	466.858,0	1.010.295	26,7	46,2	35,2
1970	162.625	557.857,9	490.779,1	974.243	29,2	50,4	38,3
1971	169.553	568.868,8	511.685,5	993.473	29,8	51,5	39,2
1972	176.601	610.453,2	532.957,2	1.066.096	28,9	50,0	38,0
1973	187.867	669.864,2	566.955,5	1.169.851	28,0	48,5	36,9
1974	200.970	645.804,4	606.498,4	1.127.833	31,1	53,8	40,9
1975	212.102	610.665,1	640.092,6	1.066.466	34,7	60,0	45,7
1976	218.564	653.708,0	659.593,5	1.141.636	33,4	57,8	44,0
1977	225.572	692.514,1	680.742,3	1.209.407	32,6	56,3	42,8
1978	230.046	716.307,8	694.245,3	1.250.960	32,1	55,5	42,2
1979	234.696	709.586,5	708.278,9	1.239.222	33,1	57,2	43,5
1980	238.077	676.600,5	718.482,6	1.181.615	35,2	60,8	46,3
1981	241.194	688.202,4	727.888,7	1.201.877	35,0	60,6	46,1
1982	243.722	656.303,8	735.516,9	1.146.169	37,1	64,2	48,8
1983	249.899	672.944,5	754.156,9	1.175.231	37,1	64,2	48,8
1984	255.958	728.568,5	772.442,1	1.272.372	35,1	60,7	46,2
1985	261.479	746.306,5	789.103,9	1.303.350	35,0	60,5	46,1
1986	267.868	750.830,4	808.386,9	1.311.251	35,7	61,7	46,9
1987	275.938	803.605,2	832.740,2	1.403.417	34,3	59,3	45,1
1988	283.260	851.078,0	854.837,7	1.486.323	33,3	57,5	43,8
1989	281.602	853.561,2	849.834,2	1.490.660	33,0	57,0	43,4
1990	273.629	851.078,0	825.772,6	1.486.323	32,2	55,6	42,3

Source: Cols (1) from table 20; col (2) is col (4) converted by the UVR with Soviet quantity weights (.331); col (3) is col (4) converted by the UVR with US quantity weights (.573); col (4) is from table 21, converted from a national accounts basis to a US census basis, i.e. blowing up all the figures by the ratio of 27.5 per cent (ratio of 1,403,417 to 1,100,300); col (5) is col (1) divided by col (2); col (6) is col (3) divided by col (4); col (7) is the geometric average of cols (5) and (6).

Table 23
Gross Value Added* per Hour Worked, Soviet and US Industry, 1928-90

	Gross Value Added per Hour Worked at USSR Prices		Gross Value Added per Hour Worked at US Prices		Gross Value Added USSR/USA, USA=100		
	USSR	USA	USSR	USA	at Soviet	at US	geometric
	(rubles)		(dollars)		quantity weights	quantity weights	average
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1928	0,9	3,8	2,8	6,7	24,0	41,5	31,6
1929	1,0	2,8	3,0	4,9	35,9	62,0	47,2
1930	1,1	3,7	3,2	6,5	28,4	49,1	37,3
1931	1,0	5,0	3,0	8,7	20,1	34,8	26,5
1932	1,0	7,2	2,9	12,6	13,3	23,0	17,5
1933	1,1	8,0	3,3	14,0	13,7	23,7	18,1
1934	1,2	8,1	3,5	14,1	14,4	24,9	18,9
1935	1,2	5,9	3,7	10,2	21,1	36,5	27,8
1936	1,4	6,0	4,1	10,5	22,8	39,4	29,9
1937	1,4	6,6	4,1	11,5	20,7	35,7	27,2
1938	1,4	10,4	4,1	18,2	13,1	22,6	17,2
1939	1,4	11,0	4,4	19,3	13,1	22,7	17,3
1940	1,2	11,8	3,7	20,7	10,3	17,8	13,5
1941		9,3		16,2			
1942		6,7		11,7			
1943		4,8		8,5			
1944		5,4		9,4			
1945	0,9	6,3	2,8	11,1	14,4	24,9	18,9
1946	1,0	6,7	2,9	11,7	14,2	24,6	18,7
1947	1,0	7,4	3,1	12,8	13,9	24,0	18,2
1948	1,1	7,8	3,4	13,6	14,4	25,0	19,0
1949	1,3	8,2	3,8	14,3	15,3	26,5	20,1
1950	1,3	8,7	3,9	15,1	15,0	25,9	19,7
1951	1,4	9,0	4,2	15,7	15,4	26,6	20,2
1952	1,4	9,2	4,4	16,0	15,7	27,2	20,7
1953	1,5	9,4	4,5	16,5	15,8	27,4	20,8
1954	1,6	9,8	4,7	17,1	15,9	27,5	20,9
1955	1,7	10,2	5,1	17,7	16,5	28,5	21,7
1956	1,8	10,2	5,3	17,8	17,3	29,9	22,8
1957	1,9	10,5	5,6	18,4	17,7	30,6	23,2
1958	2,0	10,7	5,9	18,7	18,2	31,5	24,0
1959	2,1	11,1	6,4	19,3	19,1	33,0	25,1
1960	2,3	11,3	6,8	19,7	20,1	34,8	26,4
1961	2,4	11,6	7,3	20,3	20,7	35,8	27,2
1962	2,5	12,0	7,5	20,9	20,9	36,1	27,4
1963	2,5	12,7	7,7	22,2	20,0	34,6	26,3
1964	2,6	13,3	7,9	23,2	19,7	34,0	25,9
1965	2,7	13,6	8,1	23,7	19,7	34,1	25,9
1966	2,7	13,7	8,2	23,9	19,8	34,2	26,0
1967	2,8	13,9	8,5	24,3	20,1	34,8	26,5
1968	2,9	14,5	8,7	25,3	19,8	34,3	26,1
1969	2,9	14,7	8,9	25,7	19,9	34,4	26,2
1970	3,0	15,1	9,2	26,4	20,2	34,9	26,5
1971	3,1	16,1	9,4	28,0	19,4	33,5	25,5
1972	3,2	16,5	9,7	28,7	19,5	33,7	25,6
1973	3,4	17,2	10,2	30,0	19,8	34,2	26,0
1974	3,6	16,8	10,7	29,4	21,2	36,6	27,8
1975	3,7	17,5	11,2	30,6	21,1	36,5	27,8
1976	3,7	17,8	11,2	31,1	20,9	36,2	27,5
1977	3,8	18,1	11,4	31,6	21,0	36,2	27,5
1978	3,8	17,9	11,5	31,2	21,3	36,9	28,1
1979	3,9	17,3	11,6	30,3	22,2	38,4	29,2
1980	3,9	17,2	11,7	30,0	22,6	39,0	29,7
1981	3,9	17,4	11,8	30,3	22,5	38,8	29,5
1982	3,9	18,1	11,8	31,5	21,7	37,4	28,5
1983	4,0	18,4	12,0	32,2	21,6	37,4	28,4
1984	4,1	18,8	12,3	32,8	21,6	37,4	28,4
1985	4,1	19,5	12,5	34,0	21,2	36,7	27,9
1986	4,2	20,0	12,7	35,0	21,1	36,4	27,7
1987	4,4	21,4	13,2	37,3	20,4	35,3	26,8
1988	4,6	21,9	13,7	38,3	20,8	35,9	27,3
1989	4,6	22,0	14,0	38,4	21,1	36,4	27,7
1990	4,6	22,2	14,0	38,8	20,9	36,1	27,5

* Gross value added for USSR is defined on an MPS basis; for the USA it is on a 'US census basis' (see section 4 in the text).

Source: col (1) is calculated from table 20 (col (4) divided by col (2)); col (2) is col (4) converted by the UVR with Soviet quantity weights (.331); col (3) is col (1) converted by the UVR with US quantity weights (.573); col (4) from the last col of table 21, gross value added converted from a national accounts to a US census value, i.e. blowing up all gross value added figures by the ratio of 32.8 per cent (ratio of 1,165,747 to 877,800, see table 17); col (5) is col (1) divided by col (2); col (6) is col (3) divided by col (4); col (7) is geometric average of cols (5) and (6).

Table 24
Gross Value Added*, Soviet and US Manufacturing, 1950-90

	Gross Value Added at USSR Prices		Gross Value Added at US Prices		Gross Value Added USSR/USA, USA=100		
	USSR (million rubles)	USA	USSR (million dollars)	USA	at Soviet quantity weights	at US quantity weights	geometric average
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1950	33.561,2	235.569,8	97.056,5	393.167,4	14,2	24,7	18,8
1951	37.820,8	263.616,6	109.374,9	439.977,7	14,3	24,9	18,9
1952	41.082,7	272.595,7	118.808,0	454.963,8	15,1	26,1	19,8
1953	44.649,1	292.428,6	129.121,9	488.065,1	15,3	26,5	20,1
1954	48.509,0	271.074,7	140.284,2	452.425,2	17,9	31,0	23,6
1955	53.589,3	299.521,9	154.976,1	499.903,8	17,9	31,0	23,6
1956	57.037,6	302.213,9	164.948,3	504.396,8	18,9	32,7	24,8
1957	60.046,1	303.904,9	173.648,6	507.219,2	19,8	34,2	26,0
1958	64.540,4	277.389,2	186.645,7	462.964,2	23,3	40,3	30,6
1959	70.298,2	308.948,9	203.296,9	515.637,5	22,8	39,4	30,0
1960	76.079,6	309.563,1	220.016,3	516.662,7	24,6	42,6	32,4
1961	82.043,2	310.244,1	237.262,5	517.799,3	26,4	45,8	34,8
1962	88.266,7	336.616,4	255.260,5	561.814,8	26,2	45,4	34,5
1963	91.609,6	363.273,8	264.927,9	606.306,2	25,2	43,7	33,2
1964	97.356,6	388.894,7	281.547,8	649.067,6	25,0	43,4	33,0
1965	103.513,0	422.767,1	299.351,5	705.600,8	24,5	42,4	32,2
1966	109.237,8	455.140,3	315.907,2	759.631,9	24,0	41,6	31,6
1967	117.740,3	453.907,2	340.496,0	757.573,8	25,9	44,9	34,1
1968	125.047,4	477.179,8	361.627,3	796.416,0	26,2	45,4	34,5
1969	130.847,1	490.551,9	378.399,6	818.734,2	26,7	46,2	35,1
1970	137.243,1	463.229,0	396.896,5	773.132,0	29,6	51,3	39,0
1971	142.448,6	471.176,1	411.950,3	786.395,7	30,2	52,4	39,8
1972	147.878,9	513.006,4	427.654,4	856.210,9	28,8	49,9	37,9
1973	157.671,9	567.878,1	455.974,9	947.791,9	27,8	48,1	36,5
1974	169.459,3	540.759,0	490.063,1	902.530,0	31,3	54,3	41,3
1975	178.789,3	500.453,3	517.044,8	835.259,6	35,7	61,9	47,0
1976	183.442,0	548.985,7	530.500,2	916.260,5	33,4	57,9	44,0
1977	189.126,3	589.610,4	546.938,6	984.063,4	32,1	55,6	42,2
1978	192.169,8	614.737,5	555.740,2	1.026.000,5	31,3	54,2	41,1
1979	195.955,6	617.918,1	566.688,5	1.031.309,0	31,7	54,9	41,7
1980	197.484,2	576.808,4	571.109,0	962.696,6	34,2	59,3	45,1
1981	199.709,0	593.745,3	577.542,9	990.964,4	33,6	58,3	44,3
1982	200.863,9	565.437,6	580.882,9	943.718,7	35,5	61,6	46,8
1983	205.605,9	583.487,7	594.596,3	973.844,5	35,2	61,1	46,4
1984	210.015,0	629.288,9	607.347,1	1.050.286,9	33,4	57,8	43,9
1985	214.367,0	644.476,4	619.932,9	1.075.635,0	33,3	57,6	43,8
1986	218.553,2	651.314,8	632.039,0	1.087.048,3	33,6	58,1	44,2
1987	225.350,9	698.467,7	651.697,4	1.165.746,8	32,3	55,9	42,5
1988	231.774,0	735.706,6	670.272,6	1.227.898,7	31,5	54,6	41,5
1989	229.824,8	741.913,1	664.635,5	1.238.257,4	31,0	53,7	40,8
1990	222.923,0	734.274,3	644.676,0	1.225.508,3	30,4	52,6	40,0

* Gross value added for USSR is defined on an MPS basis; for the USA it is on a 'US census basis' (see section 4 in the text).

Source: col (1) from table 20; col (2) is col (4) converted by the UVR with Soviet quantity weights (.346); col (3) is col (1) converted by the UVR with US quantity weights (.599); col (4) from col (1) of table 21, converted from a national accounts to a US census basis, i.e. blowing up all the figures by the ratio of 32.8 per cent (ratio of 1,165,747 to 877,800, see table 17); col (5) is col (1) divided by col (2); col (6) is col (3) divided by col (4); col (7) is geometric average of cols (5) and (6).

Table 25
Gross Value Added*, Soviet and US Mining, 1950-90

	Gross Value Added at USSR Prices		Gross Value Added at US Prices		Gross Value Added USSR/USA, USA=100		
	USSR	USA	USSR	USA	at Soviet	at US	geometric average
	(million rubles)		(million dollars)		quantity weights	quantity weights	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
1950	5.758,8	14.625,0	22.196,7	56.965,4	39,4	39,0	39,2
1951	6.340,4	16.236,7	24.438,6	63.243,3	39,1	38,6	38,8
1952	6.844,7	16.365,3	26.382,3	63.744,2	41,8	41,4	41,6
1953	7.347,3	16.946,1	28.319,4	66.006,6	43,4	42,9	43,1
1954	8.030,8	16.740,6	30.953,9	65.206,0	48,0	47,5	47,7
1955	9.175,6	18.477,3	35.366,3	71.970,7	49,7	49,1	49,4
1956	9.826,9	19.381,5	37.876,9	75.492,4	50,7	50,2	50,4
1957	10.892,8	19.331,2	41.985,2	75.296,7	56,3	55,8	56,1
1958	11.590,5	17.910,7	44.674,5	69.763,8	64,7	64,0	64,4
1959	12.323,8	18.897,3	47.500,9	73.606,3	65,2	64,5	64,9
1960	13.071,2	18.926,0	50.381,6	73.718,3	69,1	68,3	68,7
1961	13.773,2	19.207,3	53.087,5	74.813,9	71,7	71,0	71,3
1962	14.617,5	19.716,0	56.341,6	76.795,4	74,1	73,4	73,8
1963	15.654,4	20.542,0	60.338,4	80.012,6	76,2	75,4	75,8
1964	16.650,9	21.229,5	64.179,1	82.690,6	78,4	77,6	78,0
1965	17.512,6	21.972,5	67.500,5	85.584,6	79,7	78,9	79,3
1966	18.578,3	23.105,5	71.608,1	89.997,7	80,4	79,6	80,0
1967	19.470,7	24.151,0	75.047,9	94.070,2	80,6	79,8	80,2
1968	20.100,1	25.046,5	77.473,9	97.558,2	80,3	79,4	79,8
1969	20.966,7	25.906,4	80.813,9	100.907,7	80,9	80,1	80,5
1970	21.713,0	27.032,6	83.690,6	105.294,1	80,3	79,5	79,9
1971	22.697,3	26.597,4	87.484,4	103.599,0	85,3	84,4	84,9
1972	23.748,1	27.005,1	91.534,6	105.186,9	87,9	87,0	87,5
1973	24.837,0	26.794,1	95.731,7	104.365,2	92,7	91,7	92,2
1974	25.974,5	26.178,1	100.116,0	101.965,8	99,2	98,2	98,7
1975	27.064,7	25.231,6	104.317,9	98.279,0	107,3	106,1	106,7
1976	28.077,5	24.985,0	108.221,7	97.318,8	112,4	111,2	111,8
1977	28.959,8	25.355,3	111.622,4	98.761,1	114,2	113,0	113,6
1978	29.683,6	25.810,8	114.412,4	100.535,2	115,0	113,8	114,4
1979	30.188,0	21.832,9	116.356,5	85.041,0	138,3	136,8	137,5
1980	30.654,3	24.262,2	118.153,7	94.503,1	126,3	125,0	125,7
1981	30.805,5	22.531,3	118.736,4	87.761,3	136,7	135,3	136,0
1982	31.239,1	22.197,3	120.407,8	86.460,3	140,7	139,3	140,0
1983	31.550,4	21.650,7	121.607,6	84.331,3	145,7	144,2	145,0
1984	31.823,3	24.899,8	122.659,5	96.986,9	127,8	126,5	127,1
1985	32.008,8	25.294,6	123.374,6	98.524,5	126,5	125,2	125,9
1986	33.182,3	25.203,5	127.897,5	98.169,7	131,7	130,3	131,0
1987	33.854,0	25.203,5	130.486,7	98.169,7	134,3	132,9	133,6
1988	34.349,9	28.665,2	132.398,0	111.653,2	119,8	118,6	119,2
1989	33.687,5	25.416,1	129.845,0	98.997,6	132,5	131,2	131,9
1990	32.504,7	26.630,7	125.285,9	103.728,7	122,1	120,8	121,4

* Gross value added for USSR is defined on an MPS basis; for the USA it is on a 'US census basis' (see section 4 in the text).

Source: col (1) from table 20; col (2) is col (4) converted by the UVR with Soviet quantity weights (.259); col (3) is col (1) converted by the UVR with US quantity weights (.257); col (4) from col (1) of table 21, converted from a national accounts to a US census basis, i.e. blowing up all the figures by the ratio of 18.3 per cent (ratio of 98,170 to 83,000, see table 17; col (5) is col (1) divided by col (2); col (6) is col (3) divided by col (4); col (7) is geometric average of cols (5) and (6).

Table 26
Gross Value Added*, Soviet and US Public Utilities, 1950-90

	Gross Value Added at USSR Prices		Gross Value Added at US Prices		Gross Value Added USSR/USA, USA=100		
	USSR	USA	USSR	USA	at Soviet	at US	geometric
	(million rubles)		(million dollars)		quantity weights	quantity weights	average
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1950	951,3	14.049,5	2.874,1	24.519,0	6,8	11,7	8,9
1951	1.082,1	16.272,1	3.269,2	28.397,9	6,7	11,5	8,7
1952	1.238,3	17.476,9	3.741,1	30.500,5	7,1	12,3	9,3
1953	1.397,3	18.844,0	4.221,5	32.886,4	7,4	12,8	9,8
1954	1.562,0	20.728,0	4.719,0	36.174,3	7,5	13,0	9,9
1955	1.760,5	21.706,1	5.318,8	37.881,3	8,1	14,0	10,7
1956	1.983,5	23.409,3	5.992,6	40.853,6	8,5	14,7	11,1
1957	2.172,7	24.980,1	6.564,0	43.595,1	8,7	15,1	11,4
1958	2.439,0	26.051,8	7.368,5	45.465,3	9,4	16,2	12,3
1959	2.741,0	28.544,3	8.281,0	49.815,3	9,6	16,6	12,6
1960	3.022,4	30.640,8	9.131,0	53.474,1	9,9	17,1	13,0
1961	3.388,4	32.216,1	10.236,9	56.223,2	10,5	18,2	13,8
1962	3.823,1	33.864,6	11.550,2	59.100,1	11,3	19,5	14,9
1963	4.252,2	35.620,6	12.846,5	62.164,8	11,9	20,7	15,7
1964	4.727,4	38.069,1	14.282,1	66.437,8	12,4	21,5	16,3
1965	5.202,6	39.811,9	15.717,7	69.479,4	13,1	22,6	17,2
1966	5.599,6	42.283,3	16.917,4	73.792,4	13,2	22,9	17,4
1967	6.030,6	44.351,6	18.219,4	77.402,0	13,6	23,5	17,9
1968	6.560,4	48.605,5	19.819,9	84.825,8	13,5	23,4	17,8
1969	7.079,8	51.725,2	21.389,1	90.270,2	13,7	23,7	18,0
1970	7.620,8	53.079,9	23.023,7	92.634,5	14,4	24,9	18,9
1971	8.240,0	56.817,0	24.894,2	99.156,4	14,5	25,1	19,1
1972	8.825,2	58.550,1	26.662,4	102.181,1	15,1	26,1	19,8
1973	9.421,8	66.045,4	28.464,8	115.261,7	14,3	24,7	18,8
1974	10.051,3	67.860,6	30.366,6	118.429,6	14,8	25,6	19,5
1975	10.713,7	71.102,8	32.367,9	124.087,9	15,1	26,1	19,8
1976	11.453,3	70.388,4	34.602,3	122.841,1	16,3	28,2	21,4
1977	11.862,7	70.880,5	35.838,9	123.700,0	16,7	29,0	22,0
1978	12.415,0	70.594,0	37.507,6	123.200,0	17,6	30,4	23,1
1979	12.779,2	70.536,7	38.607,8	123.100,0	18,1	31,4	23,8
1980	13.352,2	69.677,2	40.339,0	121.600,0	19,2	33,2	25,2
1981	13.609,1	69.849,1	41.115,1	121.900,0	19,5	33,7	25,6
1982	13.958,2	65.838,1	42.169,8	114.900,0	21,2	36,7	27,9
1983	14.403,2	66.926,8	43.514,4	116.800,0	21,5	37,3	28,3
1984	15.076,0	71.453,5	45.547,0	124.700,0	21,1	36,5	27,8
1985	15.520,2	73.688,3	46.888,8	128.600,0	21,1	36,5	27,7
1986	16.070,6	72.485,0	48.551,8	126.500,0	22,2	38,4	29,2
1987	16.734,0	79.934,0	50.556,0	139.500,0	20,9	36,2	27,5
1988	17.137,7	83.830,4	51.775,6	146.300,0	20,4	35,4	26,9
1989	17.304,2	87.440,3	52.278,7	152.600,0	19,8	34,3	26,0
1990	17.364,4	88.701,0	52.460,7	154.800,0	19,6	33,9	25,8

* Gross value added for USSR is defined on an MPS basis; for the USA it is on a 'US census basis' (see section 4 in the text).

Source: col (1) from table 20; col (2) is col (4) converted by the UVR with Soviet quantity weights (.331); col (3) is col (1) converted by the UVR with US quantity weights (.573); col (4) from col (1) of table 21, it was assumed that there is no difference between the national accounts and the 'US census' basis for public utilities; col (5) is col (1) divided by col (2); col (6) is col (3) divided by col (4); col (7) is geometric average of cols (5) and (6).

Appendix A Definitions, Sources, and Adjustments

This appendix describes in detail the concepts, definitions and sources used, and the adjustments made in the USSR/USA comparison of output and productivity for 1987.

A.1 Definitions

Industry Classification

This study focuses primarily on the 'manufacturing sector' as defined in the US Standard Industrial Classification 1987 (SIC). The closest equivalent to this in the Soviet classification is the 'industry sector', which roughly corresponds to a combination of SIC manufacturing and mining. Soviet industry also includes maintenance and repair activities. Where possible Soviet definitions are adjusted to SIC.

US Standard Industrial Classification

The first principle of the US Standard Industrial Classification is that it should conform to the existing structure of American industry¹. SIC covers several levels of aggregation. The most disaggregated level consists of 'products', with a 7 digit code. For instance 'fluid whole milk, bulk sales' is SIC number 20261 12. All milk products are aggregated to the industry level 'fluid milk', SIC 2026 and to the 3-digit level 'dairy products' SIC 202. The term 'industry' is reserved for 3- and 4-digit SIC numbers. An industry code is assigned on the basis of the industry's primary activity, which is determined by its principal product. The next level of aggregation is the 2-digit branch level. In our example dairy products are combined with meat products, bakery products, etc. to form the 'food and kindred products' branch, SIC 20. According to this classification manufacturing consists of 20 branches, which for the purpose of this study were collapsed into 16 branches (see tables A.1 and A.2).

OKONKh

The Soviet classification, OKONKh ('Obshchesoyuznyi Klassifikator Otrastli Narodnovo Khozyaistva', literally: an all-union branch classification for the national economy) is in many respects different from the US Standard Industrial Classification. First of all OKONKh makes a different division by sector. Whereas SIC distinguishes between mining and manufacturing, the OKONKh concept 'promyshlennost' (industry) is a combination of mining, manufacturing, electrical power supply, fishing, and also includes industries mainly involved in repair and maintenance activities². For this comparison I adjusted OKONKh to make it as comparable as possible with the American classification.

A serious problem is that OKONKh provides no product codes. Products had to be allocated to industries on an ad hoc basis. Even at CIS-STAT³ it was not always clear to what industry a particular product belonged.

Statistical Unit

The basic statistical unit in the *1987 US Census of Manufactures* is the 'establishment'. An establishment is defined as a single physical location where manufacturing is performed⁴. The Soviet statistical unit is not the establishment but the enterprise. The consequence of the dissimilarity in statistical concepts for the comparison of output and productivity is not clear. It is likely that an establishment-based census includes more

¹ SIC Manual 1987, page 11.

² Examples of non-manufacturing OKONKh industries and their gross value of output. Mining: 11231-3 natural gas extraction 5.5 bln rubles, 13101-2 mining of chemicals 1.6 bln rubles. Power supply: 11100-1 electro-energy 30.7 bln rubles. Fishing: 18309-9 part of fish industry which is extraction 4.6 bln rubles. Repair and maintenance: 14900-2 repair and maintenance of machines and equipment 24.7 bln rubles. The share of non-manufacturing activities in total gross output of Soviet industry is almost 15 per cent (see table A.5).

³ CIS-STAT is the successor of Goskomstat USSR.

⁴ 'Explanation of Terms' in the appendix of the *1987 US Census of Manufactures*.

intermediate deliveries than an enterprise-based census since in the former inter-enterprise deliveries are recorded as intermediate deliveries, while in the latter they are not recorded at all⁵. This is another argument favouring the use of value added instead of gross output for our comparisons because an establishment-based census can lead to a higher degree of double-counting of output (since there are more intermediate deliveries) than an enterprise-based census.

Gross Output Concept

The Soviet notion of gross value of output used in this study is the 'tovarnaya produktsiya v optovyykh tsenakh predpriyatnii' (literally: commodity output in enterprise wholesale prices). Its definition can be found in the methodological explanations of the statistical yearbook 'Narodnoe Khozyaistvo SSSR' (literally: 'National Economy of the USSR'):

Gross output of industry is defined as the sum of data related to the output of individual industrial enterprises valued by the industrial method (i.e. in wholesale prices of enterprises). The value of gross output is the value of all goods produced by reporting enterprises during the record period including semi-manufactured goods sold to other entities (including own raw materials as well as customer's supplies and materials) and the value of production services for other enterprises or non-industrial divisions of the own enterprise. Gross output excludes (with some exceptions) the value of goods produced for own consumption in the production process⁶.

Soviet output is valued at wholesale prices of enterprises ('v optovyykh tsenakh predpriyatnii'). These prices cover average cost plus a mark-up for profit (Marer, 1985). Producer prices normally exclude turnover taxes. However, some turnover taxes are levied on Soviet inter-industry sales, with a great variation between branches. Correcting for this was not possible because of lack of information. US sales, from the 1987 *US Census of Manufactures*, are valued f.o.b. plant, after discounts and allowances and excluding freight charges and excise taxes.

Shipments vs Output

The 1987 *US Census of Manufactures* provides information on sales of products and industrial services rendered valued at producer prices; this information refers to the 'value of shipments'. In the USSR, by contrast, the information referred to output *produced*. The difference between US and Soviet concepts lies in the treatment of stocks. In the US census sales include the net change in stocks. Soviet output includes all production for stocks, i.e. it also includes production that is not sold.

Using a Soviet type of output concept is not a problem if one is interested in measuring productivity defined as the produced output per employee. However, producing huge quantities of unwanted goods can hardly be considered an economic way of using one's resources. Therefore, I prefer a productivity concept based on sales per employee.

Unfortunately, there is no information available on the size of Soviet stocks, or the amount of production for stocks. This need not be a serious problem for the comparison in this study on the assumption that Soviet stocks can legitimately be valued at the same prices as the output sold. For the moment it is not clear whether this is the case.

Value Added Concept

For comparisons of productivity levels we are primarily interested in value added rather than in gross output. The former excludes double counting of that part of output which is used as inputs in other enterprises or establishments. In general, value added can be

⁵ This impression is strengthened by the conclusion of Ehrlich (1985) that establishments and enterprises are considerably larger in socialist countries than in large-type capitalist countries. Ehrlich bases her conclusions on data for Czechoslovakia, East Germany, Hungary and Poland.

⁶ Translation kindly provided by CIS-STAT.

derived by subtracting intermediate inputs from gross output. Value added in the US census is derived by subtracting the cost of materials, supplies, energy and contract work from the value of shipments and adjusting for net changes in stocks of finished goods, raw materials, etc., the margin of goods merchandised or factored, and purchases of industrial services (see table A.2). This census value added concept differs from value added as reported in the US national accounts. The main difference between the two is the treatment of non-industrial services⁷. To avoid double counting of inter-sectoral input use the national accounts also deduct non-industrial services from output. The census concept does not deduct those non-industrial inputs⁸. For estimating the benchmark comparisons in this study, I use the census value added concept. Time series are however from national accounts sources.

Table A.1
Soviet Output Concepts as used in the USSR/USA Comparison

plus plus = (1)	All goods produced by individual enterprises Semi-manufactured goods sold to other entities Production of services rendered to other enterprises or non-industrial divisions of the own enterprise Gross output at producer prices (excludes turnover tax)
multiplied by = (2)	Share of material inputs in gross output as in 1987 input-output table <i>Material inputs</i>
(1) - (2) =	Value added at producer prices

Table A.2
US Output Concepts as used in the USSR/USA Comparison

plus =	Total sales of products, f.o.b. plant Industrial services rendered Value of shipments ('Gross output')
minus	Purchases: -raw materials, components, semi-manufactured goods -packaging materials -workshop materials -energy inputs
minus	Purchases of industrial services -work done on materials supplied
plus plus =	Net change in stocks of finished goods, raw materials, packaging, etc. Margin of goods merchandised or factored Value added by manufacture ('value added')

Soviet industrial statistics measure gross output and material inputs, but no value added. In my data-set, the information on material inputs is not complete. To estimate the share of material inputs in gross output I therefore used the detailed 1987 input-output table⁹. In the *1987 US Census of Manufactures* purchases of non-industrial services¹⁰ are still included in value added. In the Soviet Union, non-material supplies are not measured separately, but it is not clear to what extent such expenses are accounted for in the figures for gross output and therefore included in value added. On the assumption that the value of non-material inputs is included in Soviet output, we obtain the best possible proxy by comparing the two value added concepts as described above.

Tables A.1 and A.2 summarise the description of gross output and value added.

⁷ See also section 4 in the main text.

⁸ For a detailed description of the two concepts and a reconciliation for 1977, see Van Ark and Maddison, 1994, pp. 11-29.

⁹ Although this table has not been published, CIS-STAT kindly provided the calculated share of material inputs in gross output for 100 industrial branches.

¹⁰ For instance: insurance premiums, bank charges, hires and rents, advertising, transport and communication, etc.

Employment Concept

For Soviet employment I used figures for industrial production personnel ('promyshlennoproizvodstvennyi personal') as provided by CIS-STAT. For a description of the sources see appendix A.2. For an explanation of the difference between the published total employment figure of 38,1 million employees (Narodnoe Khozyaistvo, 1987, p. 92), and the total as used in the comparison (32,4 million employees in table A.3) see appendix A.3. This Soviet employment concept is defined as:

Industrial production personnel includes workers (refers to persons directly engaged in production of material valuables as well as in repair works, displacement of loads and rendering other material services), engineers and other technical workers, employees, apprentices, other personnel (junior services staff and guards) connected with major production activities of industrial enterprises in main and auxiliary shops and engaged in management of enterprises (including supplies, marketing, and storage of finished goods and raw materials)¹¹.

In 1987 82 percent of Soviet employees were classified as workers¹² ('blue collar') and 18 percent as employee¹³ ('white collar')¹⁴.

For the US I use the 'all employees' concept, which is defined in the *US Census of Manufactures* as:

All employees include all full-time and part-time employees on the payrolls of the operating establishments. (..) The 'all employees' number is the (..) number of production workers plus the number of other employees (..).

Production workers include workers engaged in (..) services closely associated with these production operations at the establishment.

All other employees include non-production employees of the manufacturing establishment (..). It includes sales,(..), executive, personnel (including cafeteria, medical, etc.), professional, and technical employees.

65 percent of 1987 US employment is classified as production worker and 35 percent as other employees. Persons employed in auxiliary units are not included in this concept. Therefore, I added them to all employees to make it better comparable to Soviet employment¹⁵.

¹¹ Translated by CIS-STAT.

¹² Workers (rabochiye) are persons largely engaged in physical work and either paid on a piece-rate basis or an hourly rate (from Rapawy, 1981, 2).

¹³ Employees (sluzhaschchiye) are persons paid on the basis of a monthly salary. They can be further disaggregated into: engineering-technical personnel (including management, as well as technical personnel and scientists), salaried employees (includes management and professional personnel in non-technical categories and clerical personnel), and minor services personnel (includes custodial workers, messengers, chauffeurs and guards) (from Rapawy, 1981, 2).

¹⁴ Figures from: Narodnoe Khozyaistvo v 1987 godu, p. 92.

¹⁵ For a detailed comparison of 1975 US and Soviet employment in manufacturing see Rapawy (1981).

Hours Worked

In the United States hours worked refer to the yearly average hours actually worked (i.e. excluding holidays and vacation, sickness, industrial disputes etc.) and were obtained from the US Bureau of Labor Statistics with some adjustments¹⁶. Official data on Soviet hours worked are not available in any detail. Rapawy and Kingkade (1988) make detailed estimates for 1950-1985, which were updated to 1989 by Heleniak (1990). Heleniak constructed an index for 1986-1989 using output and productivity indexes and applied that to 1975 work-hour employment figure (i.e. employment expressed in total number of hours worked). The 1975 figure was derived from annual average employment and total hours worked in industry, as reported in *Vestnik Statistiki* (no. 8, 1976)¹⁷. It is difficult to assess the accuracy of these work hour estimates as Rapawy and Kingkade themselves claim (1988, p. 53). I used Heleniak's figures to estimate hours worked for the sixteen branches of manufacturing and mining (see appendix table A.7).

Results of Using These Definitions

Tables A.3 and A.4 show levels of gross value of output and value added in national currencies, number of employees and average annual hours worked both for the Soviet Union and the United States which result from using the above mentioned definitions.

Table A.3
Gross Output, Value Added, Number of Employees and
Average Number of Annual Hours Worked by Manufacturing Branch, USSR, 1987

	Gross Value of Output (in million Rubles)	Value Added (in million Rubles)	Value Added as percentage		Average Annual Hours Worked
			of Gross Output	Number of Employees '000s	
Food Manufacturing	133,556	24,328.6	18.2	2,910.1	1,871
Beverages	11,077	1,997.7	18.0	311.8	1,871
Tobacco Products	4,719	489.8	10.4	38.7	1,775
Textile Mill Products	62,653	11,826.9	18.9	1,997.9	1,775
Wearing Apparel	33,129	9,507.0	28.7	2,336.1	1,775
Leather Goods & Footwear	13,158	3,922.2	29.8	677.7	1,775
Wood Products, Furniture & Fixtures	30,582	13,471.6	44.1	2,535.0	1,793
Paper Products	7,809	3,232.6	41.4	290.2	1,815
Chemicals & Allied Products	37,264	12,965.3	34.8	1,084.8	1,738
Rubber & Plastics	12,074	3,896.6	32.3	477.5	1,738
Oil refinery	22,043	3,655.1	16.6	170.1	1,802
Non-metallic Mineral Products	37,232	16,561.6	44.5	2,741.4	1,807
Basic & Fabricated Metal Products	88,090	28,958.6	32.9	2,752.3	1,797
Machinery & Transport Equipment	185,772	78,750.7	42.4	12,358.5	1,802
Electrical Machinery & Equipment	19,014	8,442.7	44.4	1,193.2	1,802
Other Manufacturing Industries	10,516	3,343.8	31.8	538.5	1,801
Total Manufacturing	708,687	225,350.9	31.8	32,413.8	1,801

Source: Gross value of output and employment provided by CIS-STAT. Value added derived by applying share of material cost in gross output from 1987 input-output table provided by CIS-STAT. Average annual hours worked from Rapawy, 1988. For detailed description see text appendix A.

A.2 Sources

US Manufacturing Sources

The main source for US industry information was the *1987 US Census of Manufactures* (US Department of Commerce, 1990). It gives very detailed product and industry information. Value of shipments, value added and the number of employees are given for about 450 industries, classified according to SIC (Standard Industrial Classification). The census of manufactures includes a *General Summary* which summarises the information on

¹⁶ See van Ark and Pilat, 1993.

¹⁷ Quoted by Rapawy and Kingkade, 1988. For a more detailed description see Rapawy and Kingkade, 1988.

industry level. For most products (some 10,000 products are reported) both values and sold quantities are given, so that unit values can be calculated.

Table A.4
Gross Output, Value Added, Number of Employees and
Average Number of Annual Hours Worked by Manufacturing Branch, USA, 1987

	Gross Value of Output (in million US\$)	Value Added	Value Added as percentage		Average Annual Hours Worked
			of Gross Output	Number of Employees '000s	
Food Manufacturing	282,398.2	99,018.1	35.1	1,384.2	1,893
Beverages	47,327.2	22,584.8	47.7	172.9	1,866
Tobacco Products	20,757.1	14,263.8	68.7	63.5	1,853
Textile Mill Products	62,786.4	25,660.1	40.9	698.9	2,053
Wearing Apparel	64,242.7	32,515.5	50.6	1,113.8	1,794
Leather Goods & Footwear	9,082.4	4,377.9	48.2	135.7	1,843
Wood Products, Furniture & Fixtures	107,208.6	48,975.0	45.7	1,235.1	1,964
Paper Products	108,988.7	50,488.8	46.3	654.8	1,847
Chemicals & Allied Products	229,546.1	120,777.6	52.6	1,028.4	1,922
Rubber & Plastics	86,634.3	44,436.8	51.3	863.3	1,986
Oil refinery	130,414.0	18,518.3	14.2	153.6	1,922
Non-metallic Mineral Products	61,476.6	33,383.1	54.3	554.2	2,003
Basic & Fabricated Metal Products	267,614.3	121,078.4	45.2	2,228.9	1,956
Machinery & Transport Equipment	550,605.6	255,263.6	46.4	3,965.8	1,905
Electrical Machinery & Equipment	171,286.4	95,815.3	55.9	1,689.4	1,877
Other Manufacturing Industries	275,532.4	178,589.7	64.8	3,007.8	1,885
Total Manufacturing	2,475,901.0	1,165,746.8	47.1	18,950.3	1,909

Sources: Gross value of output, value added and employment from 1987 US Census of Manufactures. Average annual hours worked from Bureau of Labor Statistics, for calculation method see Van Ark and Pilat, 1993.

Soviet Industry Sources

The information on Soviet industry is not assembled in a single source. Data on production and employment were collected monthly by Goskomstat as part of the compulsory reporting obligation of enterprises. Goskomstat collected these monthly reports and processed them, most of the information was only available for internal use. Goskomstat claims that for 1987 there was a complete coverage of enterprises. The information thus gathered formed the basis for Gosplan, the Soviet planning agency, to compile and check the production plans.

Goskomstat made some of the results of this survey available to the general public in the statistical yearbook *Narodnoe Khozyaistvo* and in more detailed publications like *Promyshlennost' SSSR* (Industry USSR). Unfortunately, these publications contain only summary information which was too limited for the present study. CIS-STAT compiled lists of industry and product information which we used as the basis for our productivity calculations from previously secret, internal publications. CIS-STAT kindly allowed me to cross-check these lists with the original documents for accuracy and completeness.

The lists with industry information as provided by CIS-STAT show value of output in wholesale prices and the average number of employees for almost 400 industries. For a few industries the cost of materials is provided too. The industry classification is according to OKONKh.

Product lists, provided by CIS-STAT as described above, show both unit values and output values (in wholesale prices) for some 1300 products. Quantities produced are not given separately but were calculated from the given unit values and output values. Products are not arranged according to the OKONKh classification, but are grouped together by industry according to their similarity.

Soviet input-output table

Because of the incompleteness of information on material inputs in the Soviet industry statistics, as discussed above, I made use of the detailed 1987 input-output table for the

Soviet Union to estimate value added. Note that the input-output table is compiled on an activity basis, so that estimates of value added using this kind of activity-based information will not be perfect¹⁸.

An input-output table was compiled annually by Goskomstat on the basis of the compulsory monthly reports received from all enterprises, and normally consisted of 18 branches. In 1987, and every five years since the late 1950s, Goskomstat conducted a special survey of industry to compile a more detailed input-output table with 100 branches of industry. In previous times these tables were not made available to the public, but, with the help of CIS-STAT, we were able to extract the necessary data from the detailed 1987 input-output table, which was used to estimate the share of material inputs to output, as described in appendix A.1. See the annex for the full 1987 Soviet input-output table supplied by the US Bureau of the Census.

A.3 Adjustments

Table A.5 shows the difference between the officially published figures for industry and the totals as given in the production survey classified according to OKONKh. Some 3 percent (29.7 billion rubles) of the published figure for gross output is not accounted for by this production survey. According to CIS-STAT this part consists of data not collected in the framework of the regular statistical system, i.e. produced by enterprises of 'closed' ministries and agencies like the Ministry of Machine Building, Ministry of Defence, etc.. Figures were submitted by these ministries and agencies only once a year and without any details. For employment the difference between the two sources is very small, about 0.6 percent of the published figure. It is surprising that the published figure is smaller than what the production survey accounts for.

As said before Soviet 'promyshlennost' (industry) is a combination of manufacturing and mining, and several other non-manufacturing activities. Table A.5 also shows which part of Soviet industrial output and employment are actually non-manufacturing. To make the present manufacturing comparison it was necessary to deduct as much as possible all Soviet non-manufacturing activities from 'promyshlennost'. The descriptions of the Soviet branch classification, OKONKh, make it not always possible to distinguish between manufacturing and non-manufacturing activities. But, with help of CIS-STAT I arrived at an estimate of Soviet manufacturing which brings it fairly close to the American concept. Table A.6 shows that close to 15 per cent of the industries classified in OKONKh are non-manufacturing.

In table A.5 it can be seen that my adjustment of industry to manufacturing means a down sizing of little over 16 percent. Rapawy (1982) made very detailed calculations to adjust Soviet industrial employment to the US classification. For 1975 he adjusts total Soviet industrial employment downwards with almost 19 percent to estimate manufacturing employment, which brings these two studies fairly close together.

¹⁸ Intermediate deliveries tend to be more important in activity based statistics. But, so will gross output. It is difficult to say what influence this will have on the ratio between material supplies and gross output which I used to estimate value added.

Table A.5
Gross Value of Output and Employment in Soviet Industry, 1987

	Gross Value of Output (billion rubles)	Number of Employees (thousands)
Manufacturing	708.7	32,414
Mining	50.2	2,045
Repair and maintenance	30.0	3,071
Other	43.2	1,168
Total industry	832.1	38,698

Source: OKONKh, which differs slightly from *Narodnoe Khozyaistvo*, 1987, and *Promyshlennost SSSR*, 1988, pp. 5. In these publications the gross value of output is given as 861.8 billion rubles, and total employment as 38.1 million employees. Other includes: fishing, primary processing of fibres, etc.

Table A.6
**Gross Value of Output of Non-manufacturing Industries in million Rubles,
and as Percentage of All OKONKh Branches, USSR, 1987**

	OKONKh industries (1)	Non-manufacturing industries (2)	(2) as per- centage of (1) (3)
I Electro-energy	30,769.4	30,769.4	100.0
II Fuel production	62,521.2	40,366.3	64.6
III Ferrous metallurgy	51,110.7	7,742.9	15.1
IV Non-ferrous metallurgy	32,753.3	0.0	0.0
V Chemicals and petro-chemicals	59,373.0	1,868.0	3.1
VI Machine-building and metal working	239,889.9	24,720.4	10.3
VII Wood, woodworking and paper	39,392.0	436.3	1.1
VIII Construction materials	33,666.4	415.4	1.2
IX Glass and porcelain pottery	2,807.7	41.5	1.5
X Light industry	119,943.7	12,514.5	10.4
XI Food	131,099.8	4,573.0	3.5
XII Microbiological	1,967.9	0.0	0.0
XIII Grain milling	24,631.0	0.0	0.0
XIV Medical production	297.6	0.0	0.0
XV Polygraphical (printing)	1,911.0	0.0	0.0
Total	832,134.6	123,447.8	14.8
'True' manufacturing	708,686.9		

Source: CIS-STAT's industry-data files.

Adjustments for Hours Worked

Appendix A.1 describes the definitions of the hours worked concept used in this study. In table A.7 I present the average number of annual hours worked for Soviet industry as estimated by Heleniak (1990) and how I redefined them for my calculations. American hours worked are presented in table A.4.

Neither Heleniak nor Rapawy give an estimate for hours in Soviet mining. I averaged Heleniak's estimate of total hours worked for Soviet industry (excluding electrical power supply) and his total hours worked estimate for manufacturing branches of industry (as in table A.7) to estimate annual average hours worked in mining (see table 12).

Table A.7
Adjustment for average annual hours worked
USSR, 1987

This study	From Heleniak, 1990, table A-1	Average Annual Hours Worked
Food Manufacturing	Food industry	1,871
Beverages	Food industry	1,871
Tobacco Products	Light industry	1,775
Textile Mill Products	Light industry	1,775
Wearing Apparel	Light industry	1,775
Leather Goods & Footwear	Light industry	1,775
Wood Products, Furniture & Fixtures	Timber, woodworking, pulp and paper	1,793
Paper Products	Pulp and paper	1,815
Chemicals & Allied Products	Chemical and petrochemical	1,738
Rubber & Plastics	Chemical and petrochemical	1,738
Oil refinery	Oil and gas	1,802
Non-metallic Mineral Products	Construction materials	1,807
Basic & Fabricated Metal Products	Ferrous metallurgy	1,797
Machinery & Transport Equipment	Machine building and metalworking	1,802
Electrical Machinery & Equipment	Machine building and metalworking	1,802
Other Manufacturing Industries	a)	1,801
Total Manufacturing	b)	1,801

notes: a) The hours for other manufacturing is the same as for total manufacturing.
b) Total manufacturing is an employment weighted average of the branches.
These hours include hours worked in non-manufacturing activities, which could not be adjusted for.

Appendix B Unit Value Ratios

To convert output to a common currency we use unit value ratios which are based on ratios of ex-factory sales values per unit of output for as many products as could be matched¹⁹. Table 4 in the main text showed number of unit value ratios, unit value ratios as weighted at either Soviet or US weights, and percentage shares of matched output in total branch output for 16 manufacturing branches, and for mining. Below I discuss table 4 per branch. See the annex for individual product matches.

When calculating unit value ratios we use products valued at producer prices, which in the case of the Soviet Union are centrally administered. These prices are the most practical to use since Soviet output is expressed in terms of the same administrative prices as the individual products.

Food, beverages and tobacco

These branches have a relatively large number of homogeneous products which explains the high number of matched products. The Soviet food branch includes several activities which SIC does not include in these three branches, like perfume and salt. Fishing activities were also included in Soviet food branch. These non-food, non-manufacturing activities were excluded as good as possible. Grain milling is considered a separate branch in OKONKh but here it is included in food, as in SIC.

It is remarkable that vegetable and fruit products are almost completely missing from the Soviet data set. This may in part be explained by the high degree of home production of these goods.

Subsidies and other forms of state intervention could be of considerable importance in the food branches.

¹⁹ For a detailed description of this method see Van Ark, 1993a.

Textiles

All four matched products belong to the knitting mill industry in which the matched Soviet products form only a very small matching percentage. Several non-manufacturing activities are included in OKONKh. Where possible these have been excluded.

Wearing apparel

Eleven product matches with matching percentages over 25 percent.

Leather and footwear

Three matches in footwear industry which cover 47 and 31 percent of Soviet and US output respectively

Wood products, furniture and fixtures

Repair and maintenance was included in several industries. Most, but not all, of these non-manufacturing activities could be excluded. Two matches were made in the saw mills industry and nine in furniture.

Paper products

For paper products the Soviet matched percentage is much higher than the American, 34 percent for the USSR and 18 percent for the US. The industry for which product matches could be made, 'pulp, paper and board mills' industry, forms a much smaller part of the paper branch in the US than in the Soviet Union. Paper products, like writing paper, stationery, etc., are almost non-existent in the USSR while they form a major part of the American paper branch.

Chemicals and allied products

In this branch the Soviet matching percentage (30%) is much higher than that for the USA (8%). The matched products in the chemical branch are concentrated in three industries: basic chemicals, agricultural chemicals and synthetic rubber. The non-matched industries, like industrial inorganic chemicals and soap and detergents, form a much more important part of the chemical branch in the USA than in the Soviet Union.

Rubber and plastics

The matching percentages are very low. The match for tyres is the most important, of which the US side is based on 1982 US unit price information updated using a producer price index.

Oil refining

Three matches with high coverage percentages. In the Soviet branch 'fuel production' many more products are included than just oil and coal products as in the United States. Fuel production also includes slate, turf, etc. and it includes mining, treatment and production activities. As far as possible I excluded the non-manufacturing activities.

Non-metallic mineral products

Six product matches were made in three industries: cement, lime and gypsum, bricks and tiles.

Basic and fabricated metal products

All sixteen product matched are basic steel products. They are concentrated in the following industries: blast furnaces, steel works and cold finishing of steel shapes, carbon steel, steel pipes and electrometallurgical products. For metal products no items could be matched, because hardly any metal product data are available for the Soviet Union. Soviet

metal products industries have a value of output which is only 15 percent of US metal product industries. Maybe this is due to a different allocation of products and industries in OKONKh.

Machinery and transport equipment

The low matching percentage for the machinery and transport equipment branch is a serious problem. This branch represents 26 percent of Soviet gross output in manufacturing and 22 percent in the USA. Products in this branch are very heterogeneous and product specifications vary greatly between the two countries. The matches are concentrated in the transport equipment industries, with a low Soviet matching percentage for cars. When looking at the individual products we see a UVR of 0.24 Rubles per US Dollar for cars, 0.14 for buses, 0.14 for trucks, and 0.16 for tractors. These products account for 98 percent of the matched items.

The low matching percentage for the branch as a whole is all the more worrying because of the exceptionally low unit value ratio. This means that on average the price of Soviet machinery products is below the general manufacturing price level. This could strengthen the general impression of low quality in Soviet machinery relative to the US, but it could also be a consequence of the planners preference of producing machinery for low prices. On the basis of available information it is not clear whether a quality adjustment should be made and if so how.

Electrical machinery and equipment

The five matched products are household appliances, which explains why both matching percentages are so low. For the Soviet Union there was no other electronic machinery product data available. An important product in this branch viz. television sets, was impossible to match because US quantity information is per unit, while Soviet quantities are given per centimetre in diameter.

The five matched products show a wide spread in unit value ratios. The average unit value ratio for the electrical machinery and equipment branch is 0.684 ruble per dollar at Soviet prices and 1.064 at US prices. This spread is caused by the very different production structure in the USA and the USSR. For example, the US produced 6 million washing machines and 13 million vacuum cleaners. The Soviet Union produced 267 thousand washing machines and 4 million vacuum cleaners. A US washing machine had a unit value of \$270, the Soviet unit value was R351. A US vacuum cleaner had a unit value of \$54, the Soviet unit value is R36. This gives a unit value ratio for washing machines of 1.30 rubles/dollar, the UVR of vacuum cleaners is 0.67 rubles/dollar. In case this industry only produced these two products this would lead to an industry UVR of 0.83 rubles/dollar at USSR quantity weights and 1.11 rubles/dollar at US quantity weights.

Other manufacturing industries

The industries which can not be attributed to any of the 15 branches have the same UVR as total manufacturing.

Total manufacturing

For the aggregation of branch UVRs to total manufacturing UVR, see Van Ark 1993a. The unit value ratio for total manufacturing is 0.46 rubles per dollar. This is the geometric average of 0.35 rubles per dollar at Soviet weights and 0.60 at US weights²⁰. Compared to earlier industry of origin comparisons with the USA as base country this constitutes a

²⁰ The geometric average, or Fisher index, is the square root of the product of the two weighing systems. It has several convenient index number properties, which makes it very useful as a summary index.

relatively large spread between the two weighing measures²¹. When we express the UVR at national weights (or Paasche UVR) as percentage of the UVR at US weights (or Laspeyres UVR) we get results shown below in table B.1.

Table B.1
Spread in Manufacturing UVRs for Total Manufacturing UVRs at National Weights/US Weights, 11 Binary Comparisons

Binary comparison	Benchmark year	Per cent (a)
Canada/USA	1987	96.3
Germany/USA	1987	96.0
France/USA	1987	90.5
Australia/USA	1987	89.6
UK/USA	1987	89.6
The Netherlands/USA	1987	89.4
Brazil/USA	1975	78.8
Mexico/USA	1975	76.7
Japan/USA	1987	68.9
Korea/USA	1987	67.9
USSR/USA	1987	57.8
India/USA	1975	52.2

(a) UVR at national weights as percentage of the UVR at US weights

Source: Van Ark (1993a), Canada/USA from De Jong (1996), France/USA from Van Ark and Kouwenhoven (1994), Australia/USA from Pilat, Prasada Rao and Shepard (1993) and The Netherlands/USA from Kouwenhoven (1993). For a more thorough discussion of the importance of this spread in UVRs see Van Ark et al. (1996).

A spread between UVRs at national weights and US weights is partly explained by the difference in production structure between the two countries. The total manufacturing unit value ratio is constructed by weighting all product matches at several stages. First the product matches are quantity weighted by the relative importance of the products in the industry. Then the industry unit value ratios are weighted by the relative share of the industries in the branch. Finally the branch unit value ratios are averaged over all branches. It will be clear that the resulting total manufacturing unit value ratio is influenced by the structure of the manufacturing sectors of the two countries under consideration. Because of the negative relationship between prices and quantities, a product with a relatively high price will be associated with relatively small quantities. The quantity weights of the other country are therefore relatively large. This will result in a higher unit value ratio when one weights at US quantities than with quantities of the own country²².

From this it follows that if the two countries have a similar production structure one would expect a small spread. When they have a dissimilar production structure wider spread is expected²³. Table B.1 clearly confirms this expectation, India and the USA have a far bigger spread than Germany and the USA. From the large UVR spread in the USSR/USA comparison we could conclude that their production structure is not very similar, which is clearly not surprising. We can also conclude that even though the Soviet Union had administrative prices the resulting unit value ratios give, at least when we look at the spread, an outcome which is in line with what we would expect in a system where prices are a reasonable proxy for relative scarcities. Van Ark et al. (1996) show that the Soviet Union had a larger spread in UVR than did the East European countries.

²¹ Van Ark et al. (1996) review 26 binary comparisons. In this section I use only those which have the USA as base country to facilitate comparability with the USSR/USA comparison.

²² See also Bart van Ark (1993a).

²³ In table B.1 a small spread is expressed as a high percentage.

Mining

For mining 6 product matches were made (2 matches for coal products, 1 for iron ore, 2 for crude petroleum and gas, and 1 for sulphur). See the annex for detailed product matches. Of Soviet and US output 68 and 57 per cent were covered respectively. The geometric average unit value ratio for mining is 0.258 rubles/dollar (0.259 at Soviet weights and 0.257 as US weights).

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