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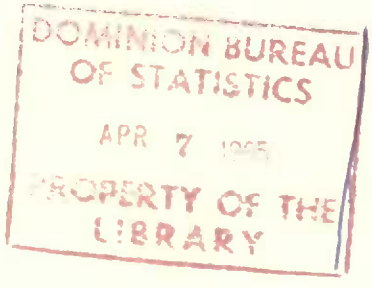
INDEXES OF OUTPUT PER PERSON EMPLOYED AND PER MAN-HOUR IN CANADA COMMERCIAL NONAGRICULTURAL INDUSTRIES

1947-63



DOMINION BUREAU OF STATISTICS

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Industry Division
Productivity Research and Analysis Section

INDEXES OF OUTPUT PER PERSON EMPLOYED AND PER MAN-HOUR IN CANADA COMMERCIAL NONAGRICULTURAL INDUSTRIES

1947-63

Published by Authority of
The Minister of Trade and Commerce

April 1965
6541-501

Price: 75 cents

ROGER DUHAMEL, F.R.S.C., Queen's Printer and Controller of Stationery, Ottawa

NOTE

The technical terms used in this report are defined in Part III, Concepts and Methods. It is noted here, however, that the terms "employment" and "persons employed" when used in the report, represent all persons engaged in the production of output, including paid workers, own account workers, employers and unpaid family workers.

FOREWORD

During recent years, the increasing interest in questions of economic growth, cost-structure and international competitiveness, and in the relationships between output, employment, earnings and prices has focussed attention on productivity as a framework within which such problems can be usefully analysed. As early as 1949, an interdepartmental committee on productivity analysis began to review the conceptual and measurement problems involved and the available data sources in Canada. It was not until comparatively recently, however, that resources became available within the Dominion Bureau of Statistics for the development of statistical measures capable of throwing light on various aspects of the relationships between input and output that are summarily called productivity.

The present reference document is the first publication in the new programme, and contains statistical series of output per person employed and output per man-hour for the universe covering the commercial nonagricultural industries as a whole, as well as for their manufacturing and nonmanufacturing components. In view of the limited resources available, efforts were concentrated on the development of measures relating output to labour input only.

Because even small errors in the components of the productivity ratios could distort or conceal true productivity movements, it is essential that the measures should be particularly precise. Since the basic data, in the form in which they are available, were not designed for and were not always readily adaptable to productivity uses, a great deal of statistical research, refinement and co-ordination was needed in the development of suitable indexes. The thorough comparative examination of a large variety of statistics which was required for the productivity programme has in consequence resulted in a substantial contribution to the improvement and integration of other economic statistics.

Since productivity measures are one of the most important indicators in analysing the performance of the economy, it is necessary that their meaning, limitations, the factors influencing them and the uses to which they can be applied should be clearly understood. The present report will therefore include not only the statistical material and a summary of the findings, but will also review these various aspects of productivity measures together with a description of the basic concepts of output and input, as well as of the methods used in the preparation of the measures.

Productivity movements at higher levels of aggregation within the economy are, of course, determined by the changes of productivity in the component economic units and by the relative shifts between them. In order to shed light on changes in the productivity of these more homogeneous economic units, the Dominion Bureau of Statistics has also initiated a number of individual industry studies, mainly in the area of manufacturing. The industries to be studied were selected, in co-operation with other government departments, so as to represent a cross section of manufacturing, including import-competing industries, export industries and typically domestic industries, and with a view to statistical feasibility and international comparability. While the aggregate statistics are designed to present an overall perspective of productivity movements, the industry studies attempt to provide a fairly refined level of industrial detail, within which it is possible to make comparisons between various types of industries and to quantify some of the underlying relationships.

The present study represents merely a beginning in the field of productivity measurement. A great deal of further research is required in both data development and the refinement of concepts and techniques if productivity statistics are to be improved and extended in coverage, detail or periodicity. It is hoped that comments and suggestions will be received from users which will help in enhancing the usefulness of the information provided.

Present plans call for up-dating the measures each year, and it is also planned to develop separate indexes for the various industry divisions within the nonmanufacturing industries.

This report was prepared in the Industry Division of the Dominion Bureau of Statistics under the general direction of V.R. Berlinguette who was an active member of the interdepartmental committee previously referred to. The Productivity Research and Analysis Section was immediately responsible for the development of the programme and for the preparation of the report under the direction of I. Bernolak, former Chief of the Section. J. Kuiper developed the statistical framework for the reconciliation of employment and man-hour data, while D.A. Worton, B. Prigly and M. Lafontaine participated in the preparation of the report. A great deal of advice and assistance was also received from other Divisions within the Bureau, particularly the Labour Division, the Special Surveys Division and the Industrial Output Section of the National Accounts and Balance of Payments Division.

In recognition of the widespread importance of the programme, an interdepartmental seminar was held during the winter of 1962-63 under the chairmanship of S.A. Goldberg, Assistant Dominion Statistician, to provide a forum for the thorough discussion of related conceptual and practical issues. The contributions of DBS officers, the representatives of various government departments and the Bank of Canada, helped a great deal in the clarification of basic problems.

The Dominion Bureau of Statistics would also like to acknowledge gratefully the advice received from statisticians and economists engaged in the preparation or use of productivity measures in a number of other countries, particularly the officials of the Bureau of Labor Statistics and the Department of Commerce of the United States. Over a number of decades, these agencies have built up an extremely broad and varied stock of experience in productivity and related measures which has been made freely available to the Bureau. The staffs of various official agencies in France, Germany, the Netherlands, Norway, Sweden and the United Kingdom, among others, have also been most co-operative in exchanging views with the Bureau on these problems.

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PART I

SUMMARY OF FINDINGS

SUMMARY OF FINDINGS

Overall Changes in Output per Unit of Labour Input, 1947-63

Between 1947 and 1963, output in the commercial nonagricultural industries increased by almost 98%, or at the rate of about 4.3% per annum.[1] During the same period, the number of persons employed in the commercial nonagricultural industries increased by 41%, or at an annual rate of 2.0%. Consequently, as is made explicit in Table 1 and Chart I, the increase in output per person employed exceeded 40% over the period in question, with an average rate of increase of 2.3% per annum. The increase in employment contributed about 47% of the increment to output, with output per person employed accounting for the remaining 53%.[2]

It can also be seen from Table 1 that the increase in employment was, to some extent, offset by a reduction in average hours per person employed, since the index of man-hours increased by only about 27%, or at an annual rate of 1.3% per annum. The increase in output per man-hour is thus correspondingly higher than that of output per person employed, being about 56%, which represents an annual rate of growth of 3.0%. Both these ratios have also been expressed in Table 1 in inverse form, i.e. as unit man-year and man-hour requirements which declined by about 29% and 36% respectively.

The increases of the two measures of output per unit of labour input were higher in the case of manufacturing alone, as can be seen from Table 2 and Charts III and IV. Output per person employed in manufacturing increased by about 51% between 1947 and 1963, while output per man-hour increased by about 62%. In terms of annual growth rates, these represented increases of 2.6% and 3.1% respectively. It will be noted that there is less difference between these rates than between those of Table 1, indicating that the decrease in average hours in manufacturing between 1947 and 1963 was smaller than that in the commercial nonagricultural industries as a whole. Output in manufacturing increased in total by almost 87%, which was about 11 percentage points less than in the case of the broader aggregate and was equivalent to an annual rate of growth of 3.7%. The number of persons employed and the number of man-hours increased by about 24% and 15% respectively, or at annual rates of 1.0% and 0.6%. Again, unit man-year and man-hour requirements have been calculated and these decreased by more in manufacturing than in the case of the commercial nonagricultural industries.

Output per person employed and per man-hour are also shown in Table 3 and Charts V and VI for the nonmanufacturing industries. The growth of the latter in terms of both output and persons employed was substantially greater than in manufacturing, being 104% and 51% respectively between 1947 and 1963. The corresponding growth rates were 4.6% and 2.5% per annum. Since, however, the increase in the number of persons employed, compared to that of output, was relatively much greater than in the case of manufacturing, output per person employed in the nonmanufacturing industries rose by only 35% over the period in question. This represented an annual rate of growth of 2.1%, considerably below the 2.6% rate for manufacturing. However, because average hours in the nonmanufacturing industries showed a greater decline than those in manufacturing, the difference between the increases of output per man-hour in the two groupings was less pronounced. At 54% overall, and 2.9% on the annual basis, the increases in the nonmanufacturing measure were closer to the figures of 62% and 3.1% noted for manufacturing.

The productivity changes described in this report are the result both of changes in productivity proper and of shifts between products, plants and industries characterized by different levels of productivity.[3]

While the available data and resources did not permit the isolation and thorough analysis of the effect of shifts at all levels of economic aggregation, there was some evidence that the shifts between the various industry divisions were in fact a contributing factor to the changes in aggregate productivity. The effect of shifts between manufacturing and nonmanufacturing in total was, however, of negligible proportions.

Year-to-year Changes in Output per Unit of Labour Input, 1947-63

Percentage year-to-year changes in output per person employed and per man-hour at the aggregate and component levels are summarized in Chart VII. The changes in the measures may also be usefully studied in conjunction with the corresponding movements of their component elements, as in Charts I to VI.

Perhaps the most important point to be considered is whether and to what extent the measures have been influenced by cyclical variations in economic activity. Since the recognition and timing of turning points are based on monthly or quarterly data, and since downturns have typically been of

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[1] In this report, the total per cent change for the period covered is given on the basis of the terminal years (the 1963 data are expressed as percentages of the 1947 data), while the average annual growth rates are calculated from the least squares trend of the logarithms of the index numbers.

[2] Based on the trend values.

[3] See pages 33-34 in the section on "Concepts and Measures of Productivity".

short duration during the period in question,[4] cyclical movements cannot be precisely identified with annual data. Furthermore, the charts suggest that cyclical influences can be more clearly identified in the movements of the output and labour input measures, their effects being partially offset when the two are brought together to derive the series of output per unit of labour input.

Nevertheless, it appears reasonable to expect that year-to-year changes in productivity might reflect the influence of cyclical factors, and this has in fact been the case. The following observations are equally relevant to measures of both output per person employed and per man-hour in the commercial nonagricultural industries and their component groupings.

Firstly, the years in which the greatest increases in productivity occurred were generally years in which output rose at a higher than average rate. This was notably the case in 1950 and 1955 and to a lesser extent in 1953 and 1959. Secondly, the poorer productivity performances frequently coincided with periods of relatively slow-growing or decreasing output, as for example in 1957 and 1960.

It does not, however, seem possible to infer from these occurrences the existence of any simple relationship between the movements of output and productivity, since the record also shows some notable aberrations from the pattern described. In 1951, for instance, a year in which the percentage changes in all three measures of output were similar to those of 1950, the corresponding productivity increases were, with the exception of output per man-hour in manufacturing, much smaller than those of 1950 and far below the averages for the whole period. This was the result of relatively large increases in labour input. Conversely, in 1958, when again output varied only slightly from the levels of the preceding year, all six productivity measures registered higher than average increases because of the sharp falls in labour input which took place.

It thus appears that the most suitable approach to the explanation of the cyclical behaviour of productivity lies in a comparison of the cyclical movements of its output and input components, with due regard to the possibility of lags in the latter. In this connection, it may be noted that, almost without exception, year-to-year increases in output were accompanied by less than commensurate increases in labour input, while decreases in output were associated with commensurately greater decreases in labour input, thus giving rise to positive, although considerably varying, productivity changes. Only in one year, 1957, was this notably not the case: in the commercial nonagricultural industries and in their nonmanufacturing component, the increases in input were greater (or, in one case, not less) than the increases in output, while in manufacturing the decrease of the output measure was accompanied by an increase in the number of persons employed and a smaller decrease in man-hours. Subject to the exception noted, the result was a decrease in output per unit of labour input in 1957.

Trends in Output per Unit of Labour Input, 1947 - 63

The identification of trend in any time series is generally recognized as a somewhat uncertain procedure even under relatively favourable conditions. In the present case, the length of the period and its terminal years were determined by considerations other than those which might be optimum for this kind of statistical analysis, and in any case the choice of a particular formulation for the calculation of trend introduces a further element of the arbitrary into the process.

As previously noted, trends have been fitted by using the least squares of logarithms method. This exponential trend, which becomes a straight line when plotted logarithmically in Charts I to VI, appears to be a good fit for the actual values of all the productivity series. There are, however, definite indications that this is not so in the case of the output and labour input components where there appears to have been a break in the exponential trend around 1956 or 1957. Thus, in the later years of the period covered, the general concurrence of somewhat lower rates of growth of output and even lower growth rates of labour input with a relatively steady rate of growth of output per unit of labour input suggests that productivity increases have become a relatively more important factor in the growth of output.

Comparisons with United States Data[5]

Charts VIII to XI show, together with the corresponding Canadian data, indexes of output per person employed and per man-hour in the private nonagricultural industries and in manufacturing for the United States. Measures relating to the private nonagricultural industries are available for the entire period from 1947 to 1963 but, pending revisions to the underlying output bench-marks, productivity indexes for manufacturing in the United States are not at present being published beyond 1959. It should be noted that, while Canadian output is expressed in terms of gross domestic product, the U.S. figures reflect a gross national product concept but, in view of the relatively small importance of the non-residents' sector in the U.S. economy, it is unlikely that the comparison is invalidated.

[4] Cyclical downturns have never lasted more than four quarters according to cycle reference dates. See, for instance, *Report of the Royal Commission on Banking and Finance*, Ottawa, Queen's Printer, 1964, page 402, Table 20-1, in which downturns are identified as running from 4th quarter 1948 to 3rd quarter 1949, 2nd quarter 1953 to 2nd quarter 1954, 2nd quarter 1957 to 2nd quarter 1958 and 1st quarter 1960 to 1st quarter 1961.

[5] Source of data for the United States: U.S. Department of Labor, Bureau of Labor Statistics. *Indexes of Output per Man-hour for the Private Economy, 1947-63.* Washington, D.C., February 1, 1964.

As in Canada, there are in the U.S. two basic sources of labour input data for use as the denominator in productivity indexes, namely establishment and labour force surveys. At the aggregate level, both are used and the relative movements of the two U.S. series of Chart VIII imply a roughly parallel movement of the underlying sets of employment data for the greater part of the period in question, in contrast to the progressive divergence between the adjusted Labour Force Survey series of paid workers in Canada and the published Canadian Employment Survey series shown later in this report.[6] For reasons which are probably the same as those operative in Canada,[7] the U.S. indexes of output per unit of labour input in manufacturing, shown in Charts X and XI, are based on labour input data derived from establishment sources. In this connection, it should be noted that the establishment data for the U.S. indexes of output per man-hour in Charts IX and XI are based on the "man-hours paid" concept, whereas the U.S. series in Chart IX, which is derived from labour force survey data, is based on the "man-hours worked" concept, as are both the corresponding Canadian indexes of Charts IX and XI.

The overall movements of the U.S. series in all four charts are quite similar to those of the Canadian series previously discussed. At the level of the commercial (private) nonagricultural industries, perhaps the more equitable comparison of the growth of output per person employed is between the Canadian series and the U.S. labour force survey-based series. This is because, although the Canadian employment series is developed predominantly from Employment Survey industrial detail, the adjustments which have been made to render it suitable for productivity purposes have brought it very close in its overall movements to the Labour Force Survey estimates for the same level of coverage. Thus in Chart VIII, the overall increases of the two indexes between 1947 and 1963 were very similar. Again, year-to-year movements were generally similar in direction and magnitude except in 1951, between 1956 and 1958, and in 1962. These observations are also broadly true of the corresponding series of output per man-hour, shown in Chart IX. It must be emphasized, however, that similarity in the growth of output per unit of labour input in the two countries does not imply a corresponding similarity in the absolute levels of output per unit of labour input.

A comparison of the indexes of output per person employed in manufacturing, shown in Chart X, indicates that growth in the U.S. series was faster in the first few years but was significantly affected by the 1954 downturn which had a less noticeable effect on the Canadian series. On the other hand, while the 1957 downturn affected the U.S. series only slightly, its effect on the Canadian series was much more severe. However, between 1947 and 1959, the overall increases of the two series were only slightly different.

Finally, valid comparison of the two series of output per man-hour shown in Chart XI is difficult because of the difference in the man-hour concept previously noted. It might be inferred, however, that if the two series were on a comparable basis, the differences in their overall growth would be somewhat smaller, because an adjustment of the Canadian input to a man-hours paid basis would lower the productivity index progressively throughout the entire period, while an adjustment of the U.S. input data to a man-hours worked basis would raise the level of the productivity index in a similar fashion.

In the comparison of the Canadian and U.S. productivity series, it should be noted that the Canadian output data for manufacturing are also subject to revision after the bench-marks are updated.[8]

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[6] See Chart A, page 39.

[7] See page 38 in the section on "Concepts, Sources and Measures of Labour Input".

[8] See page 37 in the section on "Sources, Concepts and Measures of Output".

PART II

TABLES AND CHARTS

TABLE 1. Indexes of Output per Person Employed, per Man-hour, Unit Man-year and Unit Man-hour Requirements, Commercial Nonagricultural Industries, Canada, 1947-63

(1949 = 100)

Year	Indexes of										
	Output	Persons employed	Man-hours	Output per person employed		Output per man-hour		Unit man-year requirements		Unit man-hour requirements	
				Original data	Trend values[1]	Original data	Trend values[1]	Original data	Trend values[1]	Original data	Trend values[1]
1947	92.8	94.3	95.1	98.4	97.3	97.6	96.9	101.6	102.8	102.5	103.2
1948	96.3	97.7	98.5	98.6	99.5	97.8	99.7	101.4	100.5	102.2	100.3
1949	100.0	100.0	100.0	100.0	101.8	100.0	102.7	100.0	98.2	100.0	97.4
1950	106.6	102.0	100.0	104.5	104.1	106.6	105.8	95.7	96.1	93.8	94.5
1951	113.8	107.6	104.7	105.8	106.5	108.7	108.9	94.5	93.9	92.0	91.8
1952	119.0	110.2	106.4	108.0	108.9	111.8	112.1	92.6	91.8	89.4	89.2
1953	124.9	112.1	107.5	111.4	111.4	116.2	115.5	89.8	89.8	86.1	86.6
1954	124.9	110.5	104.8	113.0	113.9	119.2	118.9	88.5	87.8	83.9	84.1
1955	136.1	114.0	107.8	119.4	116.5	126.3	122.4	83.8	85.8	79.2	81.7
1956	148.6	120.8	114.8	123.0	119.1	129.4	126.1	81.3	84.0	77.3	79.3
1957	150.4	124.3	116.5	121.0	121.8	129.1	129.8	82.6	82.1	77.5	77.0
1958	151.0	121.1	112.6	124.7	124.6	134.1	133.7	80.2	80.3	74.6	74.8
1959	159.7	124.0	115.2	128.8	127.5	138.6	137.6	77.6	78.4	72.2	72.7
1960	161.2	123.9	114.1	130.1	130.4	141.3	141.7	76.9	76.7	70.8	70.6
1961	165.5	124.9	113.5	132.5	133.3	145.8	145.9	75.5	75.0	68.6	68.5
1962	174.8	129.1	118.0	135.4	136.3	148.1	150.3	73.9	73.4	67.5	66.5
1963	183.6	133.1	120.6	137.9	139.4	152.2	154.7	72.5	71.7	65.7	64.6
1963 as % of 1947	197.8	141.1	126.8	140.1	143.3	155.9	159.6	71.4	69.7	64.1	62.6
Annual trend rate of change (%)	+4.3	+2.0	+1.3	+2.3		+3.0		-2.3		-3.0	

[1] Calculated by fitting a straight line to the logarithms of the index numbers using the least squares method.

TABLE 2. Indexes of Output per Person Employed, per Man-hour, Unit Man-year and Unit Man-hour Requirements, Manufacturing, Canada, 1947-63

(1949 = 100)

Year	Indexes of										
	Output	Persons employed	Man-hours	Output per person employed		Output per man-hour		Unit man-year requirements		Unit man-hour requirements	
				Original data	Trend values[1]	Original data	Trend values[1]	Original data	Trend values[1]	Original data	Trend values[1]
1947	93.2	96.3	97.7	96.8	95.7	95.4	95.6	103.3	104.5	104.8	104.6
1948	97.3	98.5	100.4	98.8	98.2	96.9	98.6	101.2	101.8	103.2	101.4
1949	100.0	100.0	100.0	100.0	100.8	100.0	101.6	100.0	99.2	100.0	98.4
1950	106.2	101.7	100.8	104.4	103.5	105.4	104.8	95.8	96.6	94.9	95.4
1951	115.0	107.9	104.9	106.6	106.2	109.6	108.0	93.8	94.2	91.2	92.6
1952	118.5	110.8	106.6	106.9	109.0	111.2	111.4	93.5	91.7	89.9	89.8
1953	126.4	114.2	110.5	110.7	111.9	114.4	114.8	90.3	89.4	87.4	87.1
1954	122.9	109.3	103.9	112.4	114.9	118.3	118.4	89.0	87.0	84.5	84.5
1955	134.7	112.1	107.0	120.2	117.9	125.9	122.1	83.2	84.8	79.4	81.9
1956	145.1	116.8	112.3	124.2	121.1	129.2	125.9	80.5	82.6	77.4	79.4
1957	142.9	117.3	111.4	121.8	124.3	128.3	129.8	82.1	80.5	77.9	77.0
1958	140.7	111.5	105.9	126.2	127.5	132.9	133.8	79.2	78.4	75.2	74.7
1959	149.8	112.9	107.8	132.7	130.9	139.0	138.0	75.4	76.4	71.9	72.5
1960	149.3	111.4	105.6	134.0	134.4	141.4	142.3	74.6	74.4	70.7	70.3
1961	153.0	111.2	104.8	137.6	138.0	146.0	146.7	72.7	72.5	68.5	68.2
1962	164.9	115.9	109.6	142.3	141.6	150.5	151.2	70.3	70.6	66.4	66.1
1963	173.9	119.2	112.6	145.9	145.4	154.4	155.9	68.5	68.8	64.8	64.1
1963 as % of 1947	186.6	123.8	115.3	150.7	151.9	161.8	163.1	66.3	65.8	61.6	61.3
Annual trend rate of change (%)	+3.7	+1.0	+0.6	+2.6		+3.1		-2.6		-3.1	

[1] Calculated by fitting a straight line to the logarithms of the index numbers using the least squares method.

TABLE 3. Indexes of Output per Person Employed, per Man-hour, Unit Man-year and Unit Man-hour Requirements, Nonmanufacturing Industries (Commercial Nonagricultural), Canada, 1947 - 63

(1949 = 100)

Year	Indexes of									
	Output	Persons employed	Man-hours	Output per person employed		Output per man-hour		Unit man-year requirements		Unit man-hour requirements	
				Original data	Trend values[1]	Original data	Trend values[1]	Original data	Trend values[1]	Original data	Trend values[1]
1947	92.6	93.3	93.9	99.2	98.2	98.6	97.4	100.8	101.8	101.4	102.7
1948	95.8	97.3	97.6	98.5	100.3	98.2	100.3	101.5	99.7	101.8	99.7
1949	100.0	100.0	100.0	100.0	102.3	100.0	103.2	100.0	97.8	100.0	96.9
1950	106.7	102.1	99.6	104.5	104.4	107.1	106.2	95.7	95.8	93.4	94.2
1951	113.2	107.3	104.5	105.5	106.6	108.3	109.3	94.8	93.8	92.3	91.5
1952	119.2	109.8	106.2	108.6	108.8	112.2	112.5	92.1	91.9	89.1	88.9
1953	124.1	110.9	106.1	111.9	111.0	117.0	115.8	89.4	90.1	85.5	86.4
1954	125.9	111.1	105.3	113.3	113.3	119.6	119.2	88.3	88.3	83.6	83.9
1955	136.9	115.0	108.1	119.0	115.7	126.6	122.7	84.0	86.4	79.0	81.5
1956	150.4	123.0	116.1	122.3	116.0	129.5	126.3	81.8	84.7	77.2	79.2
1957	154.1	128.1	119.0	120.3	120.5	129.5	130.0	83.1	83.0	77.2	76.9
1958	156.2	126.5	115.8	123.5	123.0	134.9	133.8	81.0	81.3	74.1	74.7
1959	164.8	130.3	118.8	126.5	125.5	138.7	137.7	79.1	79.7	72.1	72.6
1960	167.3	130.8	118.3	127.9	128.1	141.4	141.7	78.2	78.1	70.7	70.6
1961	171.9	132.6	117.7	129.6	130.7	146.0	145.8	77.2	76.5	68.5	68.6
1962	179.8	136.4	122.0	131.8	133.4	147.4	150.1	75.9	75.0	67.8	66.6
1963	188.5	140.9	124.4	133.8	136.2	151.5	154.5	74.7	73.4	66.0	64.7
1963 as % of 1947	203.6	151.0	132.5	134.9	138.7	153.7	158.6	74.1	72.1	65.1	63.0
Annual trend rate of change (%)	+ 4.6	+ 2.5	+ 1.7	+ 2.1		+ 2.9		- 2.1		- 2.9	

[1] Calculated by fitting a straight line to the logarithms of the index numbers using the least squares method.

CHART - 1

INDEXES OF OUTPUT PER PERSON EMPLOYED, COMMERCIAL NONAGRICULTURAL INDUSTRIES, CANADA, 1947-63

(1949 = 100)

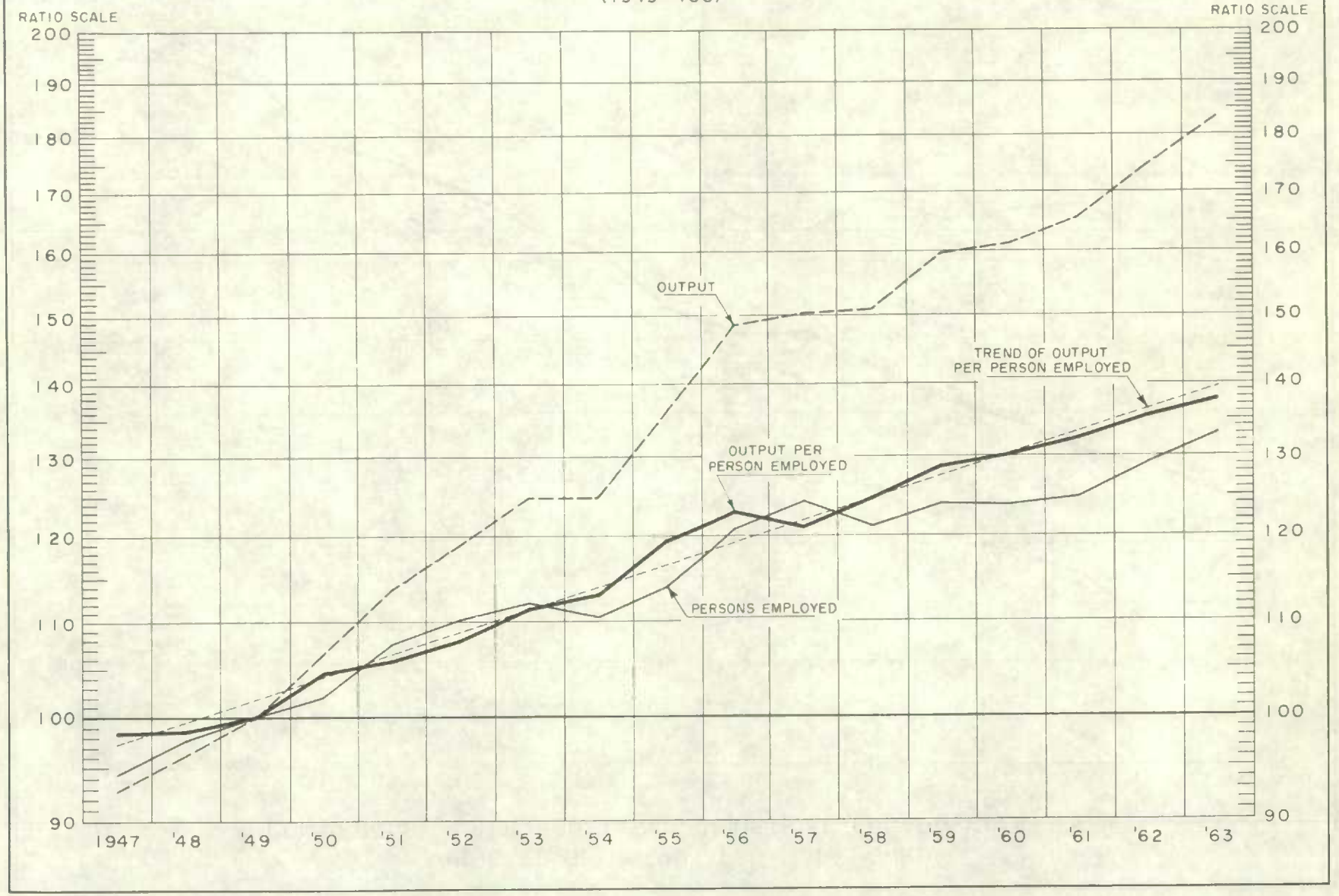

CHART-2

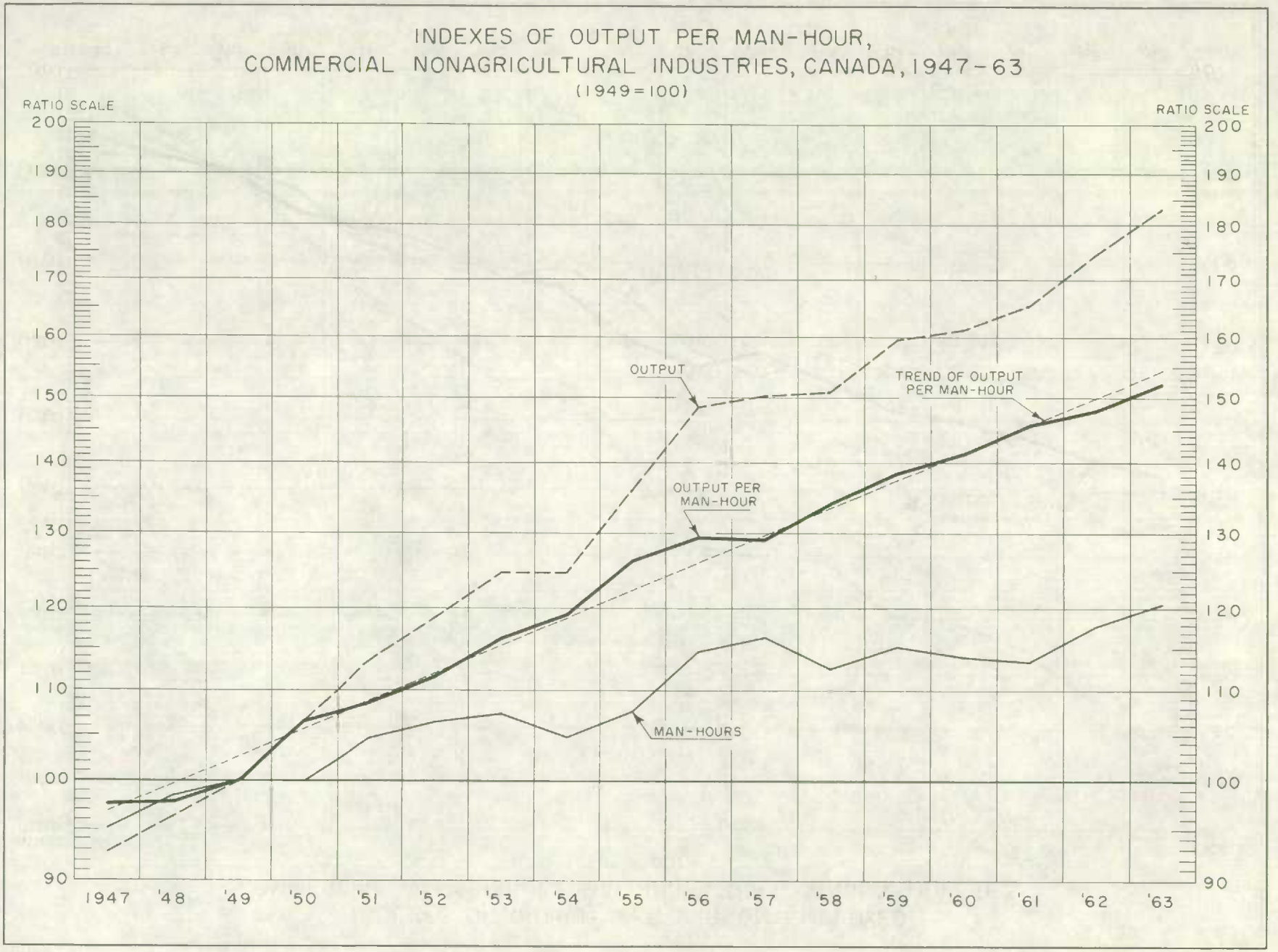
INDEXES OF OUTPUT PER MAN-HOUR,
COMMERCIAL NONAGRICULTURAL INDUSTRIES, CANADA, 1947-63
(1949=100)
RATIO SCALE
RATIO SCALE
200
190
180
170
160
150
140
130
120
110
100
90
OUTPUT
TREND OF OUTPUT PER MAN-HOUR
OUTPUT PER MAN-HOUR
MAN-HOURS
1947
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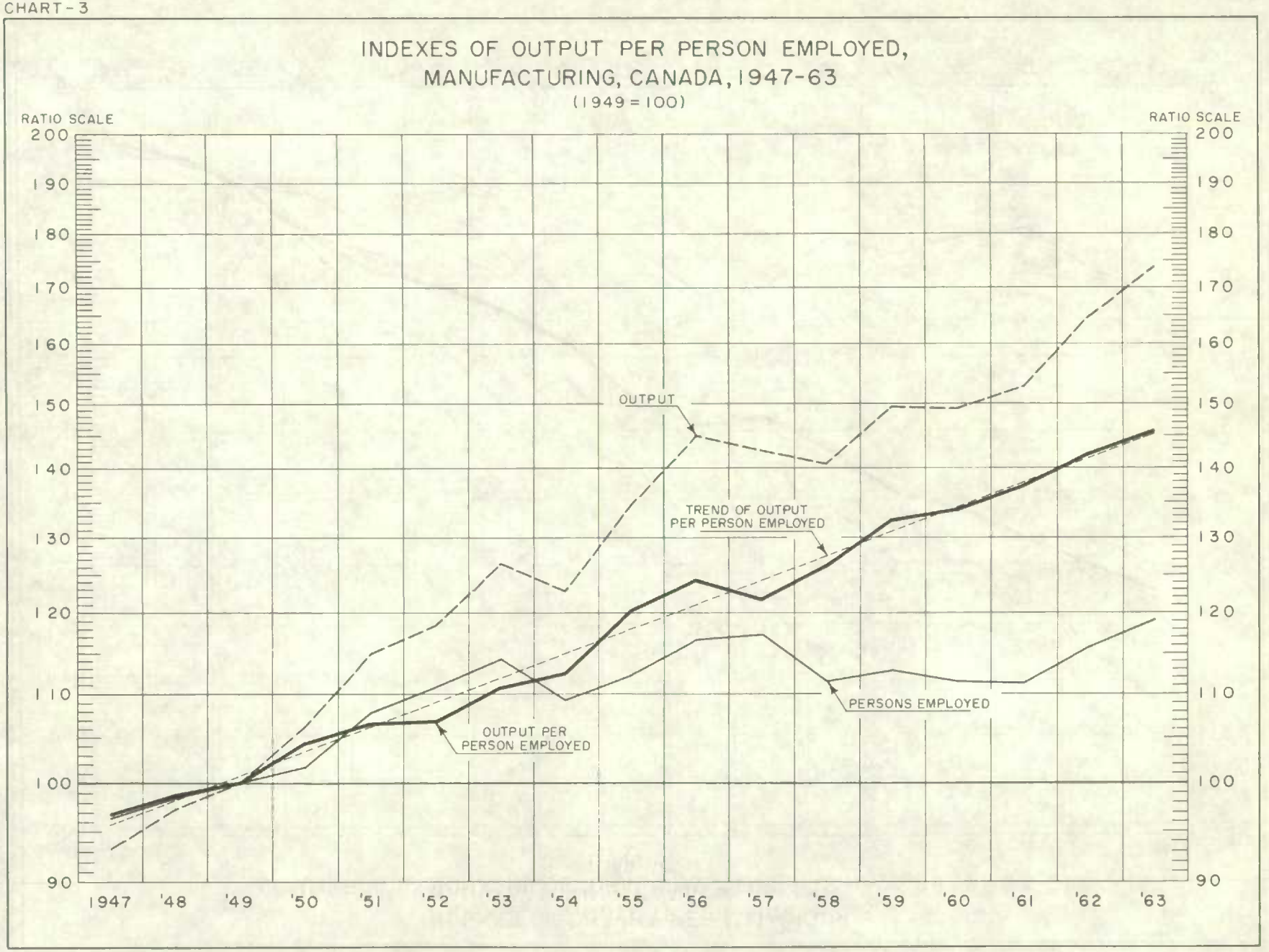
CHART - 3


INDEXES OF OUTPUT PER PERSON EMPLOYED,
MANUFACTURING, CANADA, 1947-63
(1949 = 100)
RATIO SCALE
RATIO SCALE
200
190
180
170
160
150
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OUTPUT
TREND OF OUTPUT
PER PERSON EMPLOYED
PERSONS EMPLOYED
OUTPUT PER
PERSON EMPLOYED
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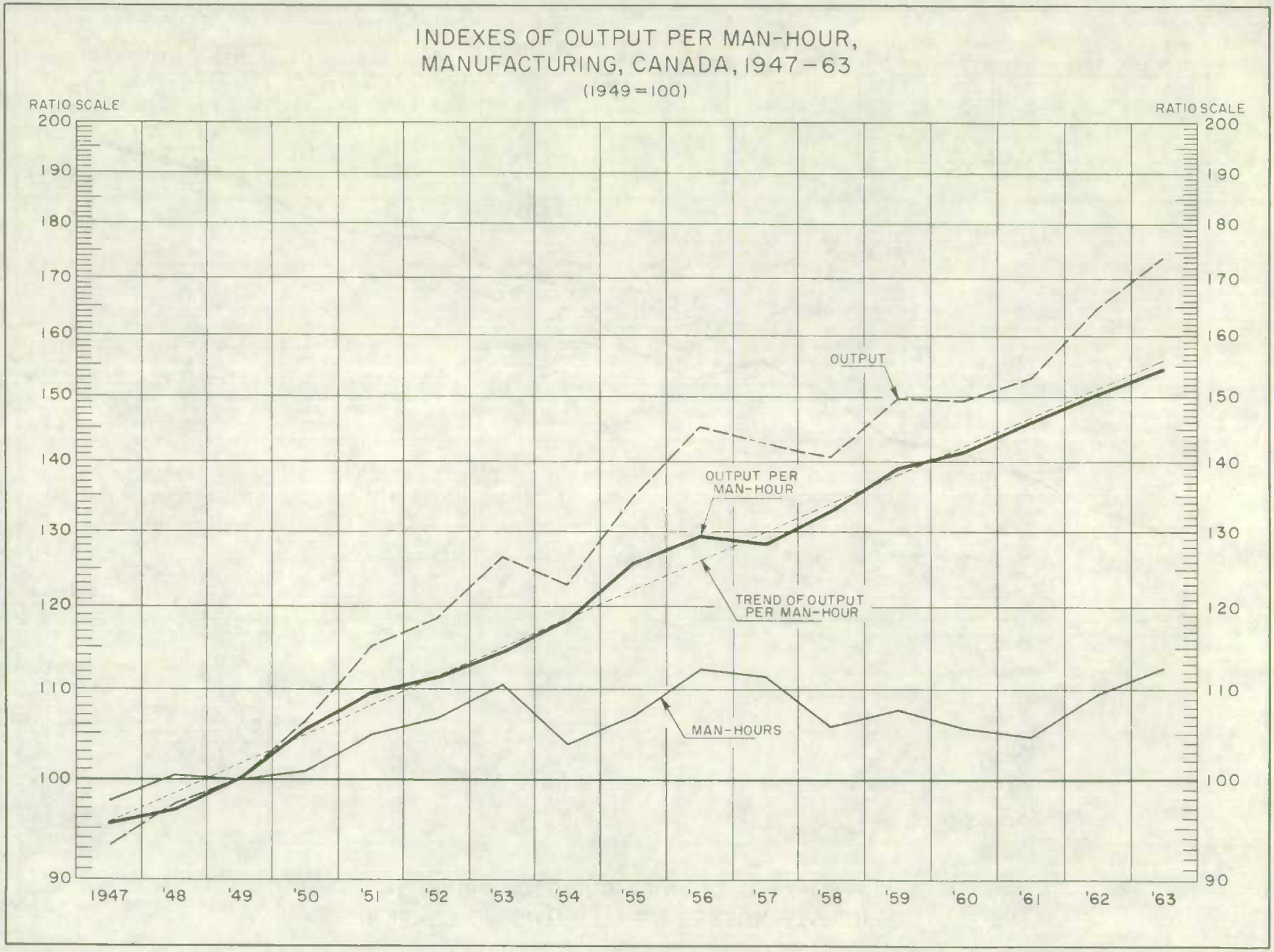
CHART-4


INDEXES OF OUTPUT PER MAN-HOUR,
MANUFACTURING, CANADA, 1947-63
(1949=100)
RATIO SCALE
RATIO SCALE
200
190
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OUTPUT
OUTPUT PER MAN-HOUR
TREND OF OUTPUT PER MAN-HOUR
MAN-HOURS
1947
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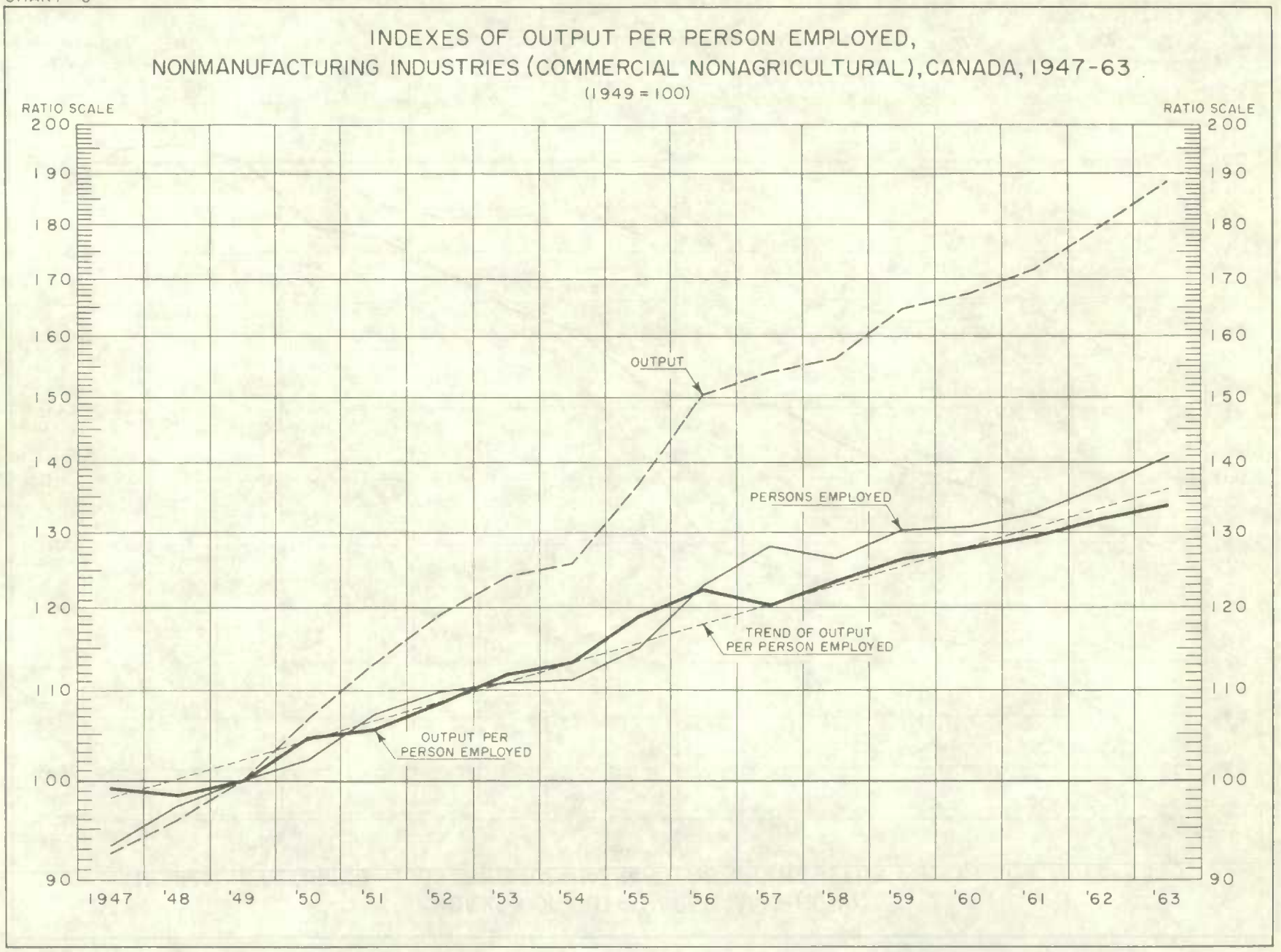
CHART - 5


INDEXES OF OUTPUT PER PERSON EMPLOYED,
NONMANUFACTURING INDUSTRIES (COMMERCIAL NONAGRICULTURAL), CANADA, 1947-63
(1949 = 100)
RATIO SCALE
RATIO SCALE
200
190
180
170
160
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140
130
120
110
100
90
OUTPUT
PERSONS EMPLOYED
TREND OF OUTPUT PER PERSON EMPLOYED
OUTPUT PER PERSON EMPLOYED
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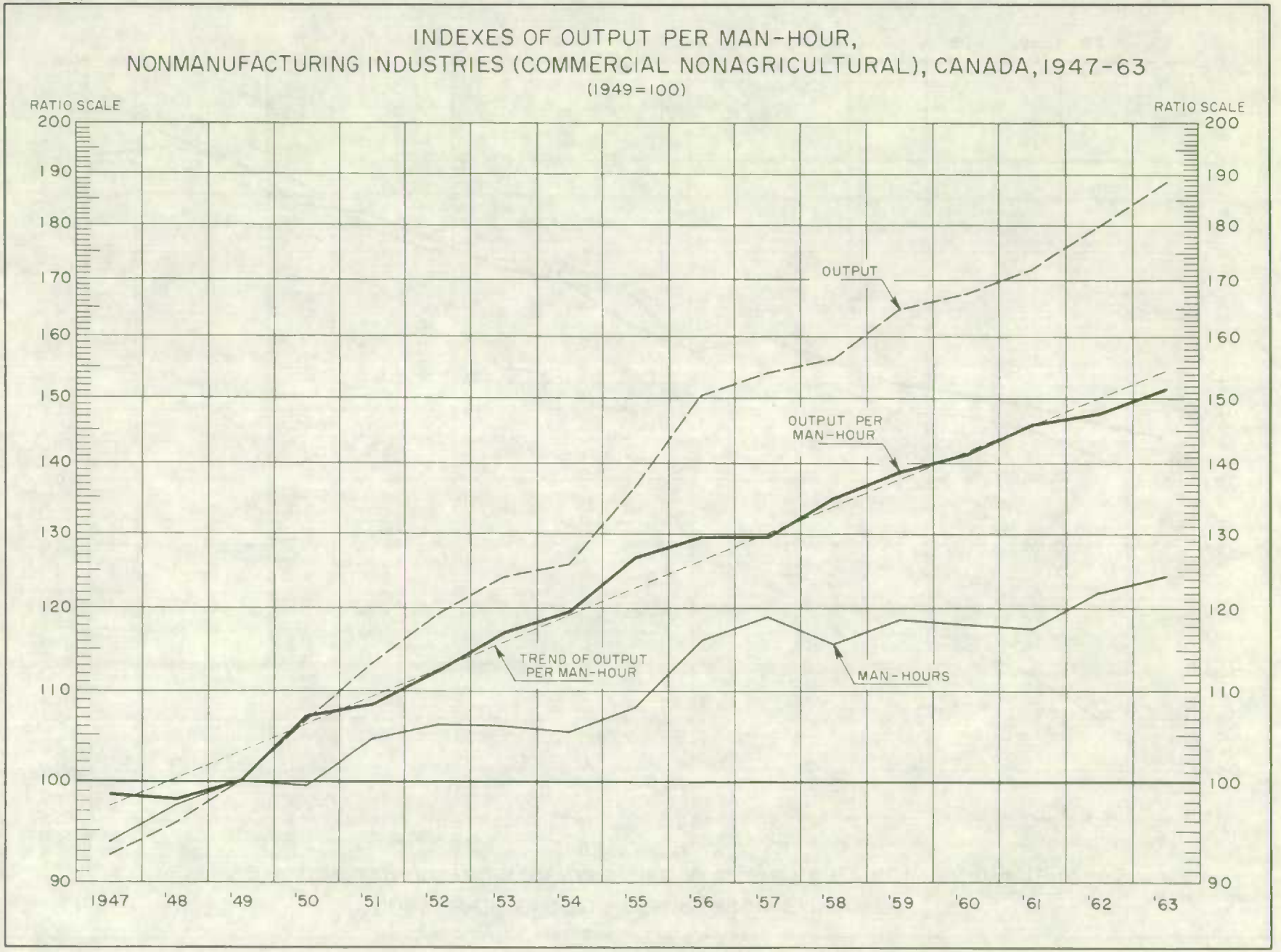
CHART - 6


INDEXES OF OUTPUT PER MAN-HOUR,
NONMANUFACTURING INDUSTRIES (COMMERCIAL NONAGRICULTURAL), CANADA, 1947-63
(1949=100)
RATIO SCALE
RATIO SCALE
200
190
180
170
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130
120
110
100
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OUTPUT
OUTPUT PER MAN-HOUR
TREND OF OUTPUT PER MAN-HOUR
MAN-HOURS
1947
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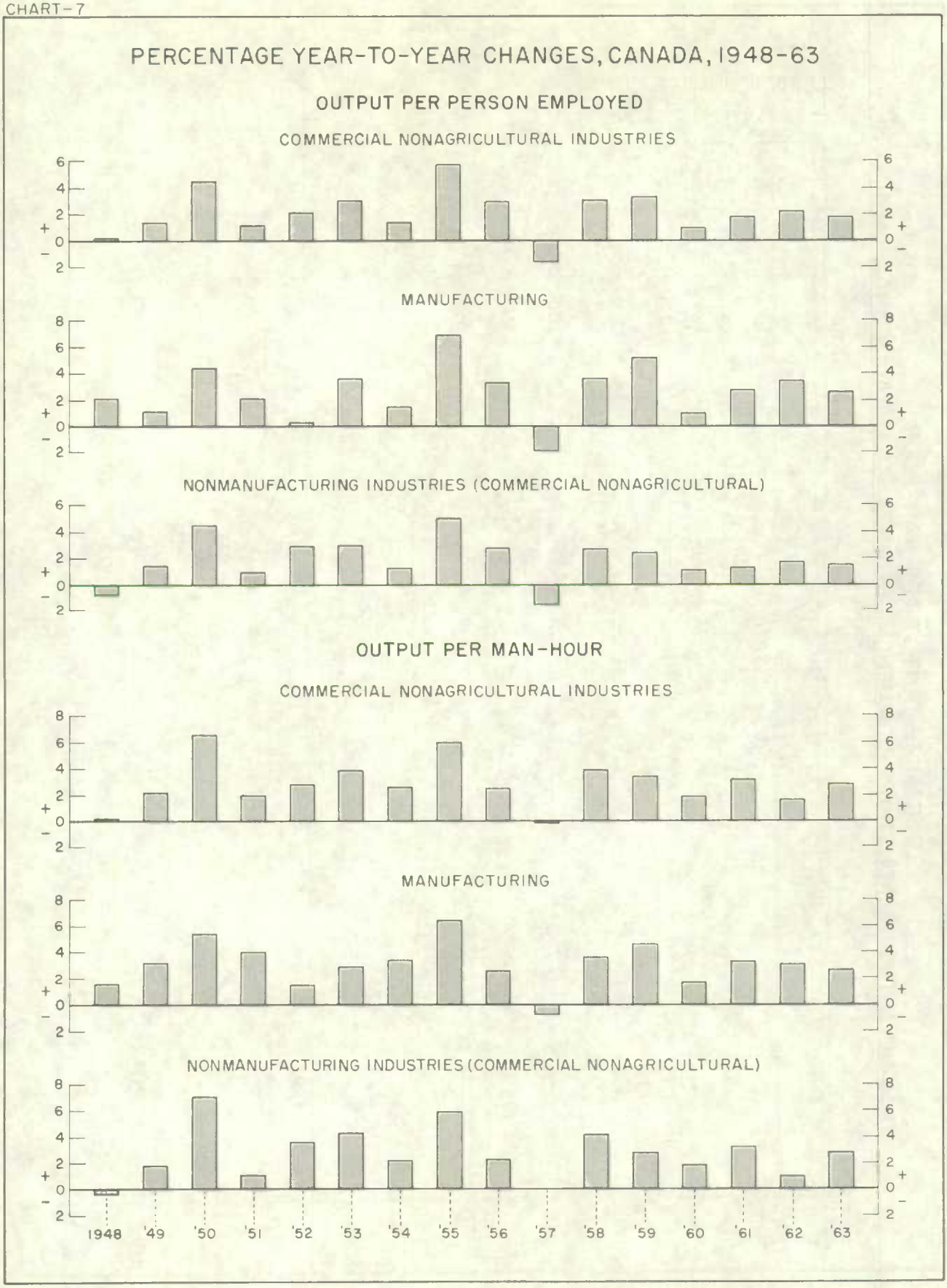
CHART–7


PERCENTAGE YEAR-TO-YEAR CHANGES, CANADA, 1948-63
OUTPUT PER PERSON EMPLOYED
COMMERCIAL NONAGRICULTURAL INDUSTRIES
MANUFACTURING
NONMANUFACTURING INDUSTRIES (COMMERCIAL NONAGRICULTURAL)
OUTPUT PER MAN-HOUR
COMMERCIAL NONAGRICULTURAL INDUSTRIES
MANUFACTURING
NONMANUFACTURING INDUSTRIES (COMMERCIAL NONAGRICULTURAL)
1948
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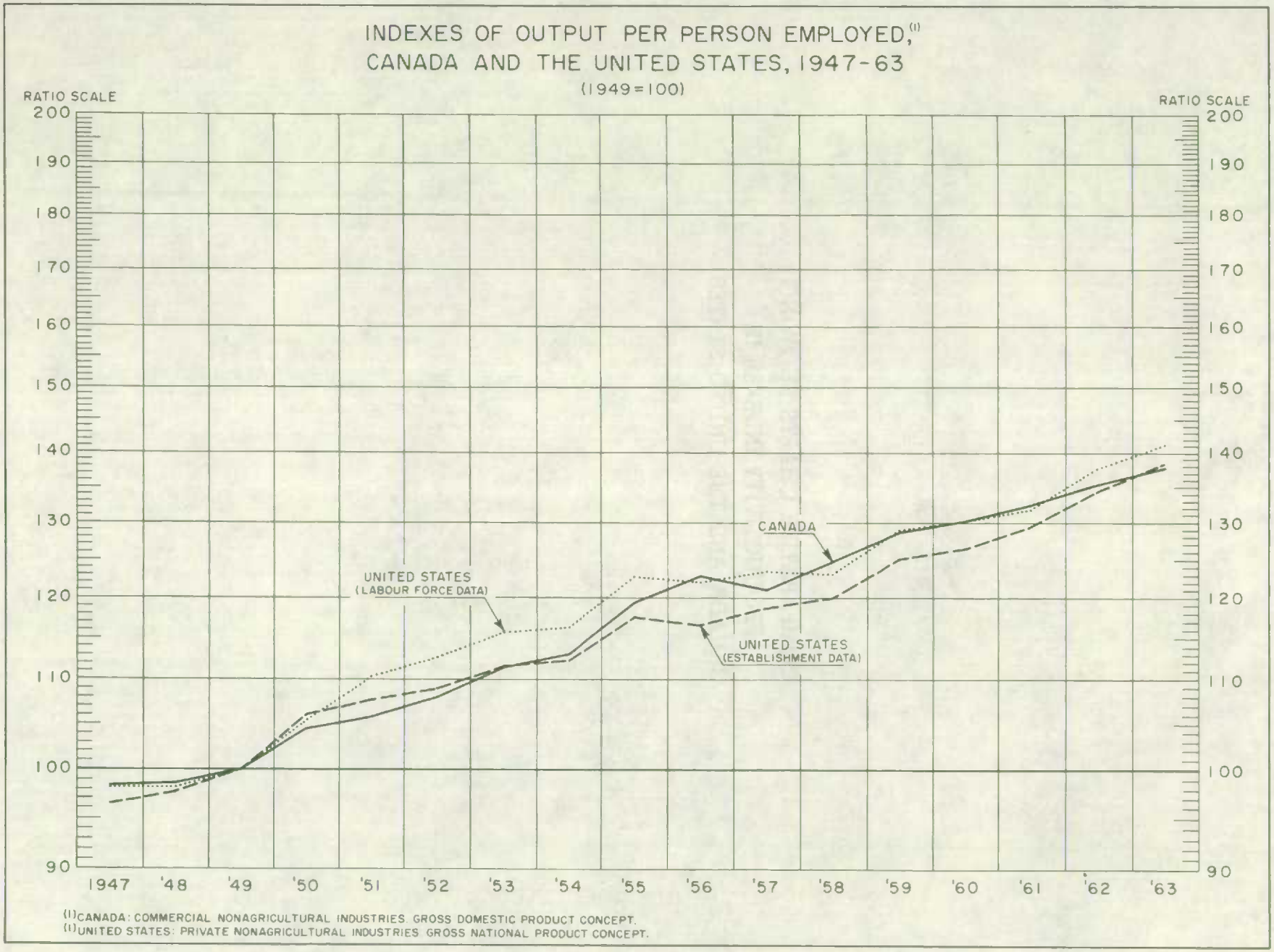
COMPARATIVE CHARTS SHOWING PRODUCTIVITY INDEXES IN CANADA AND THE UNITED STATES

CHART - 8


INDEXES OF OUTPUT PER PERSON EMPLOYED,(1)
CANADA AND THE UNITED STATES, 1947-63
(1949=100)
RATIO SCALE
RATIO SCALE
200
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180
170
160
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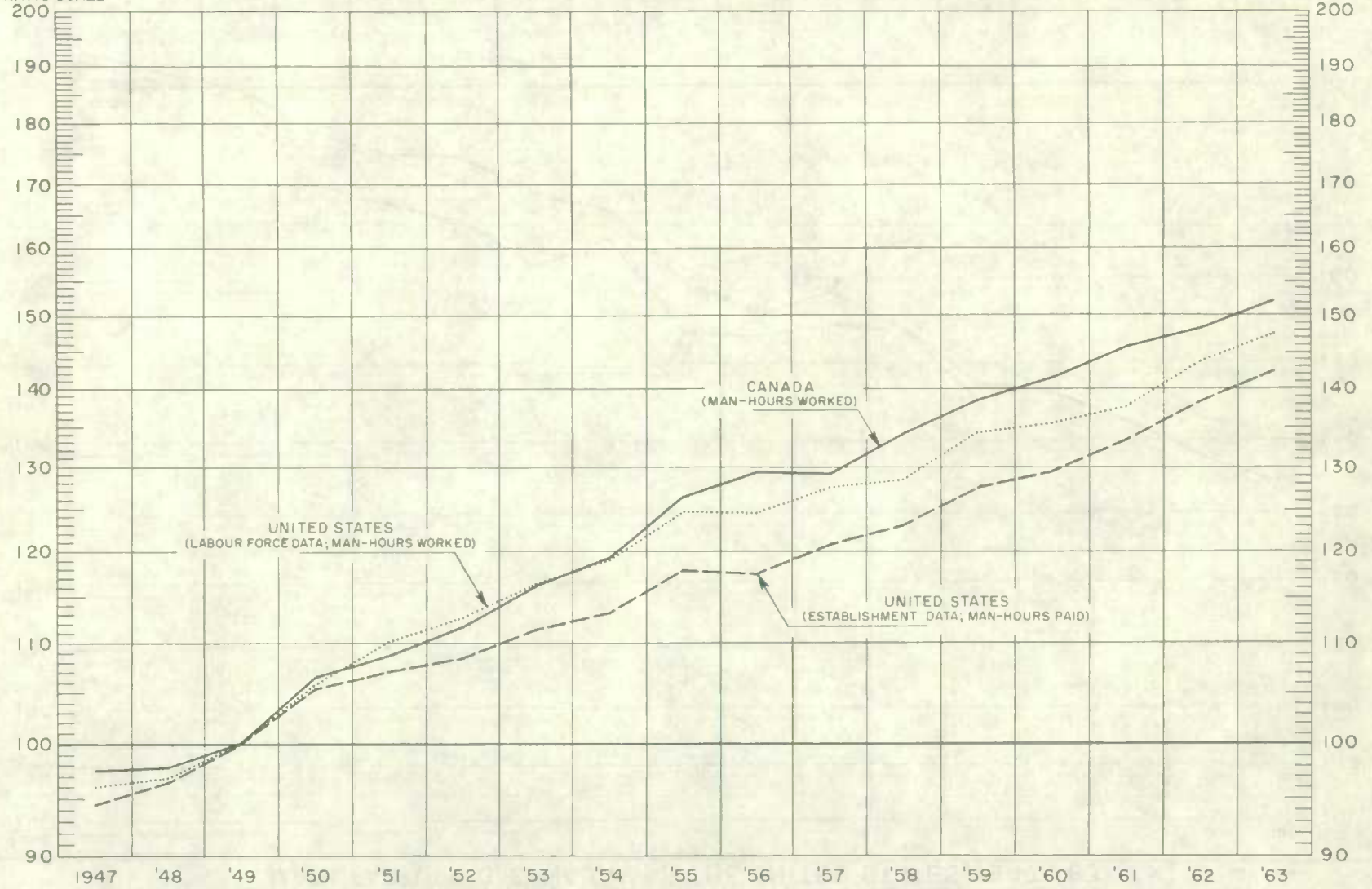
'63
CANADA
UNITED STATES
(LABOUR FORCE DATA)
UNITED STATES
(ESTABLISHMENT DATA)
(1)CANADA: COMMERCIAL NONAGRICULTURAL INDUSTRIES. GROSS DOMESTIC PRODUCT CONCEPT.
(1)UNITED STATES: PRIVATE NONAGRICULTURAL INDUSTRIES. GROSS NATIONAL PRODUCT CONCEPT.

CHART – 9

INDEXES OF OUTPUT PER MAN-HOUR,[1] CANADA AND THE UNITED STATES, 1947-63

(1949 = 100)

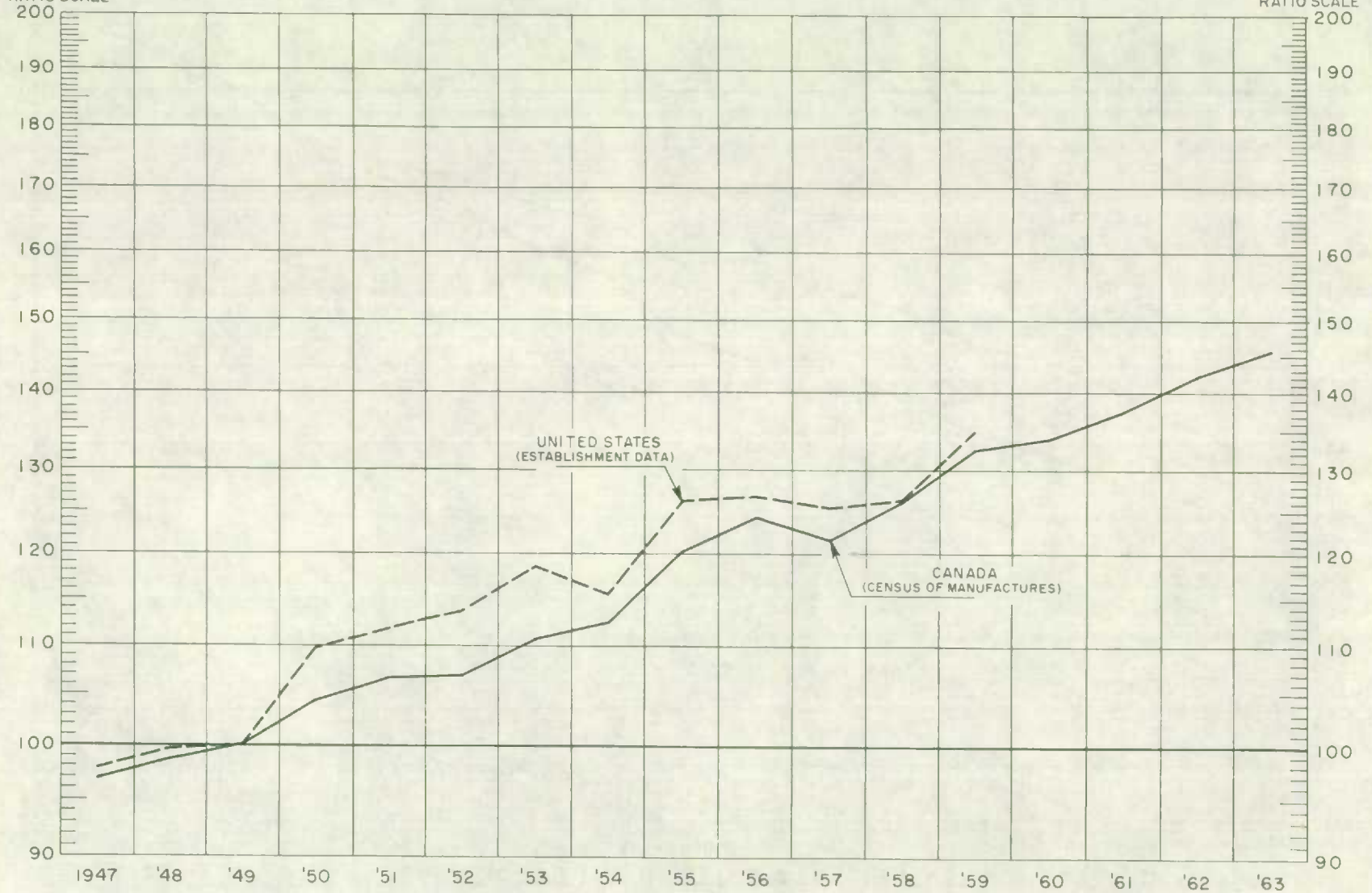


[1] CANADA: COMMERCIAL NONAGRICULTURAL INDUSTRIES. GROSS DOMESTIC PRODUCT CONCEPT.
[1] UNITED STATES: PRIVATE NONAGRICULTURAL INDUSTRIES. GROSS NATIONAL PRODUCT CONCEPT.

CHART – 10

INDEXES OF OUTPUT PER PERSON EMPLOYED,[1] MANUFACTURING, CANADA AND THE UNITED STATES, 1947–63

(1949=100)

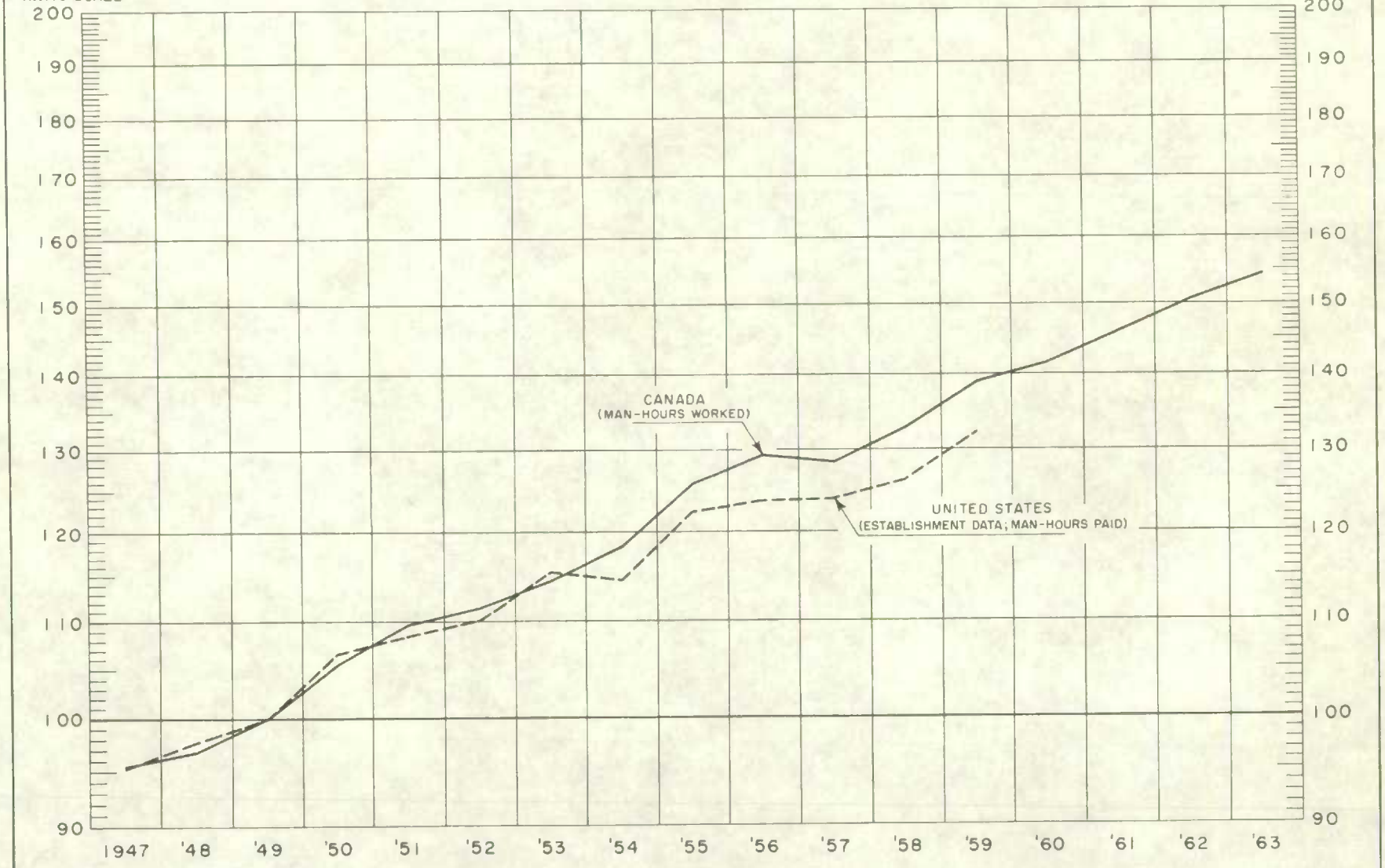


[1] CANADA: GROSS DOMESTIC PRODUCT CONCEPT.
[1] UNITED STATES: GROSS NATIONAL PRODUCT CONCEPT. DATA FOR THE YEARS 1960–63 ARE PRESENTLY BEING REVISED.

CHART-II

INDEXES OF OUTPUT PER MAN-HOUR,[1] MANUFACTURING, CANADA AND THE UNITED STATES, 1947-63

(1949=100)



[1] CANADA: GROSS DOMESTIC PRODUCT CONCEPT.
[1] UNITED STATES: GROSS NATIONAL PRODUCT CONCEPT. DATA FOR THE YEARS 1960-63 ARE PRESENTLY BEING REVISED.

PART III

CONCEPTS AND METHODS

CONCEPTS AND METHODS

Concepts and Measures of Productivity

The term "productivity" is generally used to embrace a wide variety of economic relationships. Fundamentally, productivity is a measure which expresses the relationship between output and the resources utilized in its production. More precisely, it is the ratio of output to a single input or to a combination of inputs. For instance, the volume of output per man-year or per man-hour, the number of bags of potatoes per acre, the tonnage of aluminum per kilowatt hour of energy, the number of tires per machine-hour, or ton-miles or passenger-miles per man or per unit of equipment, are all expressions of productivity. Each of these ratios is a measure of performance, relating the volume of output realized to the volume of resources used.

Productivity is not the same as efficiency. It simply expresses a physical relationship between output and input, while the notion of efficiency implies an optimum level of performance of a man, machine or an entire productive situation, very often in terms of relative cost. The movements of the two phenomena may coincide, but not of necessity.

The basic concept of productivity is twofold. Firstly, it describes a technical relationship between output and resources. In this sense it is a characteristic of the individual economic unit and its changes indicate that the productive resources within that unit have been reorganized in such a way as to affect output. The total effect of this kind of change within a given industrial aggregate can be isolated if the measure is constructed so that shifts between units with different levels of productivity are eliminated. The measure then shows whether or not the productivity of the aggregate changed in a purely technical sense.

The other concept reflects productivity changes from all sources, which are the result not only of productivity advances within the component units, but also of the shifts in production and employment between units having different levels of productivity. This second concept is more suitable for most general economic analyses and the indexes presented in this report are of this type.

The general concepts of productivity can be given expression at various levels of aggregation. Measures can be worked out for individual products, processes or plants and for industrial groupings of plants or other economic units. While the first three types of measures can normally be constructed only on the basis of plant-level studies, industry and aggregate measures can be developed from available statistics.

Comparisons of productivity can be made either with absolute data, or by means of indexes showing temporal or spatial (e.g. interfirm, interregional, international) variations. Changes over time are much more gradual than over space and are less affected by defects of available measures. Most productivity statistics developed to date are therefore time series indexes of output per unit of labour input. The indexes presented in this report are generally of this kind, but the statistical tables also show the reciprocals of the indexes, in which form they are usually referred to as unit labour requirements. These are frequently more suitable for certain purposes, for instance, the calculation of labour demand for a given projection of output. In absolute terms they also have the advantage of being directly additive because they are expressed in common units.

In theory at least, productivity measures can be designed to incorporate all measurable productive resources. If the numerator of the productivity ratio is a gross output measure, the inputs may include a single primary input (land, labour or capital) or a combination of primary inputs as well as intermediate inputs, such as material, fuel, electricity, etc. If net output measures or some approximations of the net output measures are used in the numerator, the denominator will be limited to one or more of the primary inputs.

For conceptual as well as practical reasons, most of the productivity measures that have been developed to date relate output to a single primary input, namely labour. Some of the reasons for choosing labour input as the single factor in the denominator of most productivity ratios are that it is a resource common to all industries, that it usually represents a major part of value added in production, and that labour time can be measured with relative ease. The development of output per unit of capital input measures and of "total factor" productivity measures combining both labour and capital inputs[9] depends, of course, on the availability of estimates of the stock of fixed capital. The Bureau's work on the measurement of capital stocks is still in the experimental stages, although publication of a monograph dealing only with the manufacturing industries is planned in the very near future.[10] For illustrative purposes, the latter will contain a selection of output-capital ratios based on alternative assumptions as to the average lives of assets. While the Bureau's official programme of productivity measurement is presently confined to output per unit of labour input measures, future plans call for the refinement and extension of the output per unit of capital input ratios referred to and their analysis in a broad productivity context.

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[9] Such as those developed by John W. Kendrick. *Productivity Trends in the United States.* Princeton, Princeton University Press, 1961.

[10] The methods of measurement and some of the conceptual and data problems involved are described in the feature article of the July 1964 issue of the *Canadian Statistical Review* (DBS Catalogue No. 11-003).

The variations of the productivity concept can be expressed in a number of different formulae. These have been described in various publications[11] and will not be repeated here in detail.

The basic formula used throughout this report may be expressed as follows:

$$\text{Productivity Index} = \frac{\text{Real Output Index}}{\text{Labour Input Index}}$$

or, in Algebraic form:

$$P = \frac{q_i}{q_o} \div \frac{l_i}{l_o} = \frac{q_i l_o}{q_o l_i} \qquad \text{.....(1)}$$

where P is the productivity index, and q and l are volume measures of output and labour input respectively at the appropriate level of aggregation, and the subscripts o and i indicate the base year and given year values of the terms.

Since the output of an industry is rarely homogeneous, the component products must be combined with the use of weights, such as base year or current year unit labour requirements, unit labour costs, unit value added or unit value. If output measures thus calculated are used in the numerator of productivity ratios, the various resultant indexes will, of course, be different and will have different interpretations.

For purposes of a purely physical measure of productivity, the ideal weights for combining products would be their unit labour requirements. Thus, using current year unit labour requirements as weights, the basic formula (1) would read:

$$P = \frac{\Sigma\, q_i r_i}{\Sigma\, q_o r_i} \div \frac{\Sigma\, l_i}{\Sigma\, l_o} \qquad \text{.....(2)}$$

where r is the unit labour requirement necessary for the production of q.

Since total man-hours are equal to the sum of the various products times their respective unit man-hour requirements, i.e. $l = qr$, formula (2) can also be expressed as:

$$P = \frac{\Sigma\, q_i r_i}{\Sigma\, q_o r_i} \div \frac{\Sigma\, q_i r_i}{\Sigma\, q_o r_o} = \frac{\Sigma\, q_o r_o}{\Sigma\, q_o r_i} \qquad \text{.....(3)}$$

which would show the changes in labour time required to produce the base year output, thus permitting the calculation of productivity indexes free of the effect of shifts. However, the necessary unit man-hour requirements data for individual products and services, which can normally be obtained only from direct plant studies, are rarely available and substitute weights would therefore have to be used. The most common substitute weights for combining products within industries are base year unit values. Using such weights, formula (3) would read as follows:

$$P = \frac{\Sigma\, q_i p_o}{\Sigma\, q_o p_o} \div \frac{\Sigma\, q_i r_i}{\Sigma\, q_o r_o} \qquad \text{.....(4)}$$

where p_o refers to base year unit values. This formula results in productivity indexes which include the effect of shifts between products. In order to eliminate the effect of shifts between industries, it would then be necessary to aggregate the industry productivity measures by means of man-hour or employment weights. The data necessary to compile such weights are actually available and could have been used.

For the purposes of this report, however, in which the productivity measures were designed to be conceptually consistent with the national accounts, the industry output measures were aggregated by means of value added weights[12] and divided by simple aggregates of the corresponding labour input measures. The resultant productivity indexes include the effect of shifts between products, plants and industries, but in an overall measure these shifts should be considered a contributing factor to the changes in aggregate productivity. It is hoped that, in the course of the future development of the productivity measurement programme, the effects of shifts between industry divisions can be isolated and analyzed.

Problems and Limitations of Productivity Measures

Productivity measures can be easily misinterpreted and misused unless their limitations are clearly understood. These are twofold: conceptual and statistical.

It should be strongly emphasized that the use of a labour measure as the denominator of productivity ratios does not mean that productivity or its changes were brought about by the contribution of labour alone. All these ratios actually say is that, compared to the common yardstick of labour time, the relative output is of a certain magnitude or has changed by so much. These ratios do not, by themselves, indicate the factors responsible for productivity changes, although the comparison of their variations with those of other data relating to the economic units under scrutiny may suggest at least some of the reasons for changes in productivity.

The statistical problems arise mainly on account of questions of the adequacy of available data for productivity purposes and the need for

[11] E.g. International Labour Office. *Methods of Labour Productivity Statistics*. Geneva, 1951 – Jerome A. Mark. Industry indexes of output per man-hour. *Monthly Labor Review*, Vol. 85, No. 11, November 1962. p. 1269-73. – Allan D. Searle. Relationships between productivity measures. *Monthly Labor Review*, Vol. 77, No. 5, May 1954. p. 552-7. – Irving H. Siegel. On the design of consistent output and input indexes for productivity measurement. In *Output, Input, and Productivity Measurement*. A Report of the National Bureau of Economic Research, Inc. Princeton, Princeton University Press, 1961. p. 23-41.

[12] For further details see page 37 in the section on "Sources, Concepts and Measures of Output.

particular precision in the components of productivity ratios as well as the proper matching of input data with output data.

Data problems which have to be faced in developing the productivity measures include response errors, statistical gaps, surveys inadequate for productivity uses, the lack of sufficient frequency of some basic data, and questions of classification. While the problems of labour input should not be minimized, as will be seen from the discussion of the development of the measures used in this report, the difficulties faced in preparing suitable output series are even greater. For instance, in some of the service industries, notably the financial intermediaries, real output is very difficult to define let alone measure and, pending further basic research, it has been necessary for the time being to make use of measures based on labour input. On the reasonable assumption that some kind of productivity change is taking place in the industries concerned, the incorporation of such output measures into aggregate productivity indexes is a source of error in the latter of unknown magnitude and direction.

Some of the limitations of the measures are neither conceptual nor statistical but are due to the fact that their improvement might involve prohibitive costs or place an excessive burden on respondents.

The consistency and matching of input and output measures are also difficult problems. The available data may be perfectly suitable for the purposes for which they were originally compiled, but may require various adjustments as to concepts, coverage, classification, and other basic characteristics before they can be incorporated into productivity measures.

In view of these considerations, productivity measures must be prepared and tested very carefully and even then should be looked upon as general indicators only rather than as precision tools.

Factors Affecting Productivity

Productivity measures cannot be interpreted and used properly without regard to the factors that are responsible for the level and changes of productivity. Numerous studies have been carried out on the various factors that bring about changes in productivity. It is, of course, impossible to enumerate all of the factors, but some of the more important can be reviewed by way of example.

There is a strong interaction between the various factors and they are therefore difficult to group into clearcut categories. It is nevertheless possible to distinguish factors, the effects of which are gradual, from those causing sudden changes. General educational standards, scientific progress and capital accumulation are among the typical factors determining the trends, while fluctuations in demand and competition and spurts of investment are three factors which may cause abrupt changes.

Innovation, technological change and increased capital investment are among the most important factors increasing productivity. On the other hand, by better utilization of known techniques and of the capacity of existing equipment, productivity can also be increased significantly.

On the part of the worker, his skill and training, his ability and adaptability, willingness and effort, job interest, stability and mobility are among the more important factors. Better human relations and communication, training programmes, improved working conditions, accident prevention and incentive pay systems have also been found to enhance productivity.

Managerial practices obviously affect productivity, and can be consciously directed towards its improvement. Some of the policies which have been found to promote productivity include: specialization, standardization, simplification and the lengthening of production runs; product research, quality control and planned maintenance; the elimination of bottlenecks, waste and seasonal fluctuations; better layout, work studies and long-term planning. Furthermore, productivity measurement itself has beneficial effects on productivity, because it focusses attention on weak points in the production system and stimulates productivity consciousness.

Productivity is also influenced by such general factors as cultural environment, and educational and health standards. Again, public policies determine such factors as the legislative framework, and fiscal, monetary and tariff policies. These factors also include supporting government services, such as scientific research and statistical information.

Uses of Productivity Measures

A number of countries have been using productivity measures for some time as tools with which to analyse such problems as the effects of technological change on employment, the development of appropriate policies to combat inflation and strengthen international competitiveness and, more recently, the definition of attainable goals of economic growth in which productivity increases play a major part.

The periodic concern with inflation, for instance, brings productivity to the centre of attention, because it is one of the basic determinants of the relationships between prices, costs and output. In this connection, it may again be emphasized that, while the measurement process determines the extra volume of output per unit of labour input, the resultant productivity measures do not show what factors are responsible for the increase in productivity. Furthermore, productivity measures cannot show how the extra volume of production should be distributed.

Again, measures of productivity are useful for assessing the international competitiveness of the economy. This use is, however, still very limited

today, due to the lack of sufficient comparability between the measures of most countries. Various international agencies, such as the International Labour Office, the Organisation for Economic Co-operation and Development, and others are making efforts to bring about more international statistical co-ordination for productivity measurement purposes.

In many areas, productivity measures are not only used for analysing the past but in making projections, such as for labour market or output trends. In this general connection, it must be kept in mind that neither the trend of productivity nor its shorter-term movements should be mechanically extrapolated without regard for changes in the underlying causal factors and possible cyclical fluctuations.

In the preparation of the productivity measures presented in this report, a first step has been made, within the limits of available data and resources, towards providing the data necessary for meeting the above mentioned needs.

Coverage, Classification and Reference Base

The purpose of the aggregate productivity research programme of the Dominion Bureau of Statistics is to provide measures of the overall movements of productivity in the Canadian economy and its main components. It is therefore necessary to limit the coverage to the territorial boundaries of Canada, i.e. to relate labour input to the gross domestic product concept of output rather than to that of gross national product. The need to provide productivity estimates for the main industrial components of the economy again points to the need for the gross domestic product concept because this is the measure which is available for measurement of real output by industry of origin.

The ideal productivity measure for the entire Canadian economy would be the ratio of the total real domestic product and all labour engaged in its production. For conceptual and practical reasons, two important areas had to be excluded from the measures for the time being, namely the non-commercial industries and agriculture.

Briefly, the noncommercial industries are composed of public administration and defence and other services which are not established for the purpose of making a financial gain, e.g. educational institutions and hospitals. Since there is no true market value for their transactions, real output is conventionally measured by deflated primary inputs. If an output index based on such a measure were divided by a labour input index, the resultant productivity measure would remain unity by definition or merely reflect changes in capital input or in capital consumption allowances.

The above convention could be accepted for productivity measurement only if it were definitely known that the noncommercial industries were not affected by the causal factors underlying productivity change. This is obviously not the case, and the inclusion of the available output measures for the noncommercial industries would seriously distort the aggregate productivity measures. It was therefore decided to limit the indexes presented in this report to the commercial industries only.

Agriculture has been excluded, at least for the time being, mainly because of measurement difficulties rather than for conceptual reasons. For instance, the measurement of man-hours worked by farmers, their paid employees and unpaid family workers in farming and related activities as opposed to household chores and personal activities is subject to a great deal of uncertainty.

The relative shares of output and employment in the sectors covered by this report as well as those excluded, are shown in the following table:

Percentage Contribution to Aggregate Real Domestic Product and Total Employment of the Various Sectors of the Canadian Economy

Sector	Real domestic product		Persons employed	
	1947-49 average	1961-63 average	1947-49 average	1961-63 average
	per cent			
Total domestic economy	100.0	100.0	100.0	100.0
Commercial nonagricultural industries	80.5	82.8	67.0	71.3
Noncommercial industries	8.1	8.9	10.3	17.9
Agriculture	11.4	8.3	22.7	10.8
Commercial nonagricultural industries	100.0	100.0	100.0	100.0
Manufacturing	33.9	31.7	36.2	32.1
Nonmanufacturing industries	66.1	68.3	63.8	67.9

All statistical series in this report have been constructed on the basis of the 1948 Standard Industrial Classification, using 1949 as the general reference base and, in the case of the output components, as weight base. While the introduction of up-to-date weights may result in some revision of the more current output and productivity figures, such a rebasing will not be possible until the results of the 1961 input-output table become available.

Due to statistical gaps and problems in the prewar years, the series have been developed for the postwar period only. The year 1946 is not considered suitable for inclusion as the first year in the series because it was influenced by severe postwar disruptions.

The periodicity of data in this study is annual for two reasons. First, primary interest centers in the long-term behaviour of productivity, although monthly or quarterly measures can also be extremely useful for purposes of business cycle analysis. Secondly, the data which are available at the present time for such measures are somewhat less reliable than those which are available on an annual basis, mainly because of the lack of up-to-date real output bench-marks.

Sources, Concepts and Measures of Output

Indexes of output, acceptable for productivity measurement purposes at aggregate levels, are available in Canada in a recent DBS reference paper[13] which also describes in considerable detail the concepts and methods used in their construction. Further information on indexes for individual industries covered by the Index of Industrial Production, is available from an earlier DBS reference paper.[14] A general review of early Canadian experience in the development of real output measures, and some views on their potential use in productivity studies are contained in a study by Berlinguette and Leacy.[15]

It is therefore not necessary to describe the real output measures at length in this report. The following comments are restricted to a brief review of the basic concepts and methods used as well as the applicability of the indexes for productivity measurement purposes.

The ideal numerator for aggregate productivity ratios is a measure which expresses, in real terms, the unduplicated contribution of each component industry to total output, and which can be reconciled conceptually and statistically with the national accounts. From currently available Canadian data, this concept can be approximated by combining in volume terms the "value added" by each industry, which differs from the true "net output" concept by its inclusion of intermediate service inputs. Indirect taxes less subsidies are excluded in order to show the output of each industry in terms of factor cost, thereby putting them on a comparable valuation basis. The use of the term "gross" in "gross domestic product" indicates the inclusion of capital consumption allowances which cannot at the present time be separated from measures of gross domestic product by industry of origin. The data are generally based on establishment statistics which makes them particularly suitable for industry analyses.

The Canadian annual real output indexes were constructed mainly on the basis of gross output or value added and, where such measures were not available, by the use of material input or labour input projectors. Indexes for more than 80 per cent of the gross domestic product were based on the first two types of measure. Labour input projectors were used mainly in the noncommercial industries which are excluded from the present study. Annual bench-marks were used up to 1958 with the exception of the group of industries covered by the Index of Industrial Production for which bench-marks have not been prepared since the release in 1959 of the relevant reference paper which included bench-marks up to about 1953. Work is now under way on the updating of bench-mark data. Manufacturing is the most important industry division concerned, and it is possible that, when up-to-date bench-mark data become available, the index of output for this industry division will be revised significantly. On the basis of a preliminary review of selected data for 1960, there seems to be some evidence that the adjustment will be upward. It should also be noted that some of the projectors used for want of up-to-date bench-marks are based on man-hours adjusted for estimated productivity trends, and thus there is an element of circularity in the results.

The industry indexes were combined with base year primary input value (factor cost and capital consumption allowances) weights, derived mostly from the 1949 input-output table worksheets.[16]

A principal reason for the suitability of the real gross domestic product indexes for productivity measurement purposes at the aggregate level is that their movements are well corroborated by those of deflated gross national expenditures. Before they can be used, however, for the construction of

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[13] Dominion Bureau of Statistics. *Indexes of Real Domestic Product by Industry of Origin, 1935-61.* Ottawa, Queen's Printer, 1963 (DBS Catalogue No. 61-505) and Dominion Bureau of Statistics. *Annual Supplement to the Monthly Index of Industrial Production.* Ottawa, Queen's Printer, May 1964 (DBS Catalogue No. 61-005).

[14] Dominion Bureau of Statistics. *Revised Index of Industrial Production, 1935-1957.* Ottawa, Queen's Printer, 1959 (DBS Catalogue No. 61-502).

[15] V.R. Berlinguette and F.H. Leacy. The estimation of real domestic product by final expenditure categories and by industry of origin in Canada. In *Output, Input, and Productivity Measurement.* A Report of the National Bureau of Economic Research, Inc. Princeton, Princeton University Press, 1961. p. 203-43.

[16] Dominion Bureau of Statistics. *Supplement to the Inter-industry Flow of Goods and Services. Canada. 1949;* Ottawa, Queen's Printer, 1960 (DBS Catalogue No. 13-513).

productivity indexes at finer levels of industrial detail, the individual measures will have to be scrutinized and may need further refinement. The difficulties are due to such causes as the lack of sufficient commodity detail and the resultant problems of changing quality and "product mix". The studies to be carried out in the industry productivity measurement programme of the Dominion Bureau of Statistics, which were mentioned in the Foreword, will have to be based on refined output bench-marks.

Concepts, Sources and Measures of Labour Input

In productivity measures which relate output to labour input, the labour component should refer to all persons employed. Since the entire composite of an establishment's labour force contributes to the final output, whether in production or management, engineering and other "nonproduction" activity, for general economic analyses it is conceptually desirable to relate output to all persons employed. Besides this basic ratio, output per production and related worker may also be calculated and used for certain more specialized purposes (e.g. in studies related to actual plant processes). In this report, however, the terms "persons employed" or "employment" are always used to denote all persons engaged in the creation of output. Almost 90 per cent of all these "persons employed" in the commercial nonagricultural industries were paid workers in recent years. The remaining "other than paid workers" category includes self-employed persons (employers and own-account workers) and unpaid family workers.

The basic labour input concept for productivity ratios is labour time, measured by man-year equivalents of persons employed or by man-hours, which in turn may be measured by man-hours worked or man-hours paid. Labour input is, however, hardly more homogeneous than output. The age, sex, skill, education, ability, training and occupation of the persons employed vary considerably and change over time. Nevertheless, there is no satisfactory method known by which variations and relative changes in these characteristics can be allowed for. For certain purposes this is a shortcoming, although for other productivity uses the unweighted measure may be desirable. In some productivity studies,[17] the industry labour input measures have been weighted by average hourly earnings when combined at higher levels of aggregation. In the present study, simple measures of labour time were used as the input factor.

The labour input component of productivity ratios should ideally originate from the same source as the output component. In practice however, particularly at high levels of aggregation, various labour series must be selected, tested, adapted and combined into aggregate measures which should then be conceptually and statistically consistent within themselves and also with the output data.

[17] See Kendrick. *Quoted work.*

In Canada there are two major sources of employment and man-hour statistics for the universe covered by this study, the monthly Labour Force Survey and the monthly Employment Survey. The statistics from these sources can be supplemented where desirable by data from the annual Censuses of Manufactures and of Mining, the decennial Censuses of Population and of Merchandising and Services, and elsewhere. In view of their different basic purposes, they vary in coverage, concepts and methods. Each has certain advantages and disadvantages for productivity uses.

The Labour Force Survey covers all members of the civilian noninstitutional population in Canada, 14 years of age and over, with the exception of the Yukon and Northwest Territories and Indians on reservations. It includes data for all persons engaged in productive activities including paid workers, self-employed persons and unpaid family workers. It is the only source of information on man-hours worked for the entire economy. On the other hand, it is a household-type sample survey which was not designed for use at the industry division level in sensitive indicators such as productivity indexes.

The other major source, the Employment Survey, is based on establishment statistics, and is therefore more suited for matching with the output measures, which are also based on establishment data. However, during the period to which the productivity measures in this report relate, the Employment Survey covered only establishments employing 15 persons or more, and therefore varied considerably from industry to industry in its coverage. Furthermore, the information collected in this survey refers to paid workers only. Since 1961, the coverage has been extended to include small establishments on a sample basis,[18] which has made possible an extensive use of Employment Survey data in constructing the aggregate labour input measures. In comparative terms, the source most suitable for productivity purposes is the annual Census of Industry which provides matching input and output data, although it also requires certain adjustments before it can be used for productivity measurement.

Since the real domestic product originating in the relevant industries was accepted as the numerator of the productivity index, the main problem in the construction of the index was to produce the best labour input measure matching each industry's output, and to combine them into a consistent aggregate labour input series.

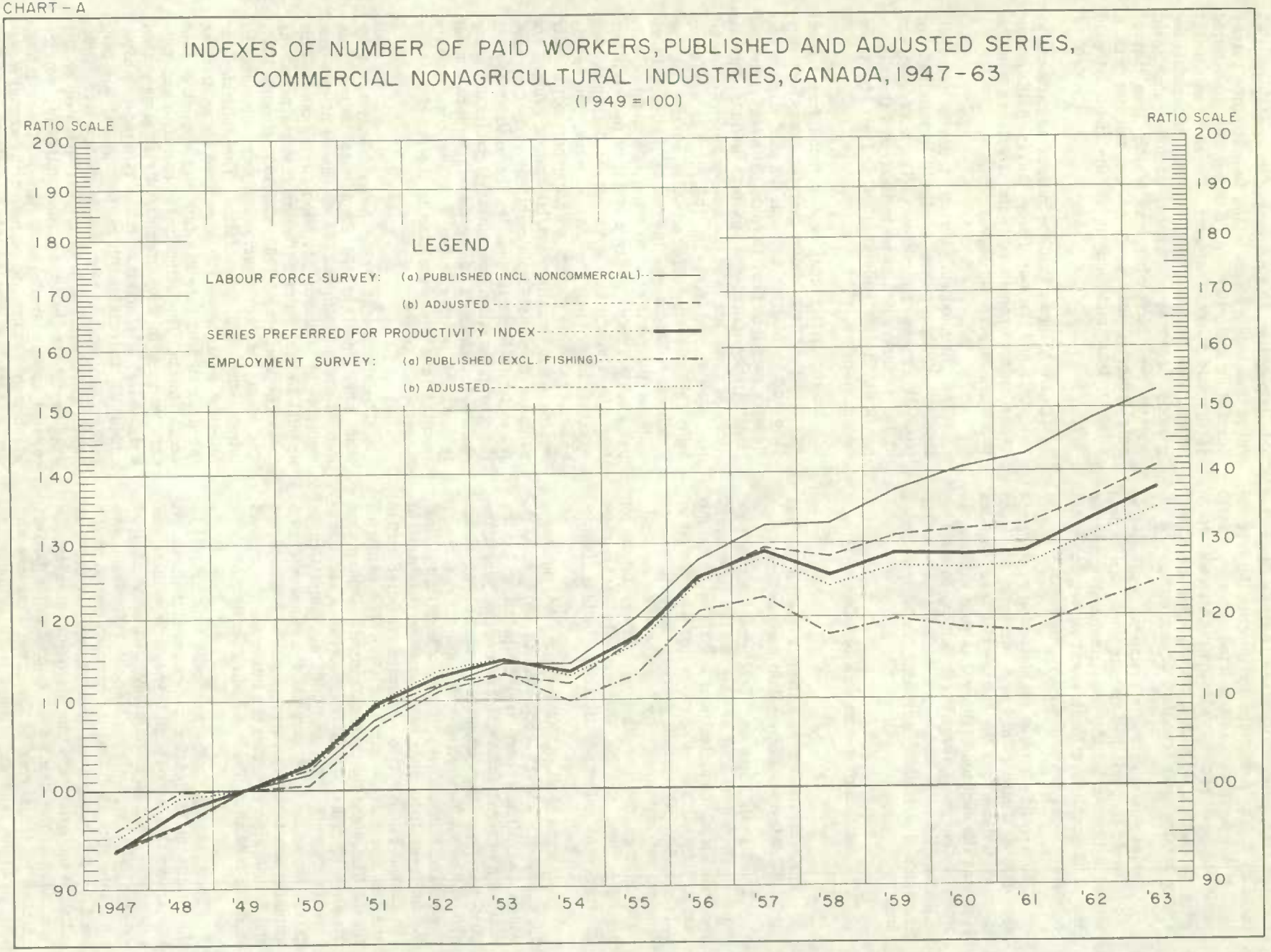
The methods used in the development of the labour input measures are now described:

(a) Persons Employed

Published data relating to paid workers were available from both the Labour Force Survey and the Employment Survey. However, these series diverged

[18] The new complete-coverage Employment Survey data will shortly be published in: Dominion Bureau of Statistics. *Estimates of Employees by Province and Industry, 1961-64.* Ottawa, Queen's Printer, 1965 (DBS Catalogue No. 72-503).

CHART – A


INDEXES OF NUMBER OF PAID WORKERS, PUBLISHED AND ADJUSTED SERIES,
COMMERCIAL NONAGRICULTURAL INDUSTRIES, CANADA, 1947–63
(1949 = 100)
RATIO SCALE
RATIO SCALE
LEGEND
LABOUR FORCE SURVEY: (a) PUBLISHED (INCL. NONCOMMERCIAL)
(b) ADJUSTED
SERIES PREFERRED FOR PRODUCTIVITY INDEX
EMPLOYMENT SURVEY: (a) PUBLISHED (EXCL. FISHING)
(b) ADJUSTED
200
190
180
170
160
150
140
130
120
110
100
90
1947
'48
'49
'50
'51
'52
'53
'54
'55
'56
'57
'58
'59
'60
'61
'62
'63

considerably, particularly since 1957, as illustrated in Chart A. The first step, therefore, in the preparation of the aggregate labour input indexes, was to reconcile these series by eliminating elements which were not relevant, by adding certain missing elements and by making some technical adjustments.

Tables showing the adjustments made to the index based on published Labour Force Survey paid worker estimates for the nonagricultural industries and to the published Employment Survey industrial composite index are presented in Appendix A.

The second step was the selection of the most appropriate measure of paid workers for each industry division from the various sources. The third step was the addition of other than paid workers, as obtained from the Labour Force Survey, to the best estimates of paid workers, summing these to the aggregate level and converting them into index form.

The detailed procedure was as follows:

(1) Reconciliation of Labour Force Survey and Employment Survey Paid Workers Series

The Labour Force and Employment Survey paid worker series were first adjusted to the coverage of the commercial nonagricultural industries. The major part of this adjustment consisted of the removal of paid workers employed in noncommercial industries (government and community services and domestic service) from the Labour Force Survey totals for nonagriculture. On the Employment Survey side, coverage was extended slightly to include fishing.

A geographical adjustment to the published Labour Force Survey estimates of paid workers, which had already been revised to allow for the inclusion of Newfoundland for a complete year in the 1949 base, was then made in respect of the Yukon and Northwest Territories which are not covered by the Labour Force Survey. The Newfoundland figures for the year 1949 were calculated on the basis of the Labour Force Survey estimates for October 1949 and the four surveys taken in 1950. The estimates for the Yukon and Northwest Territories, which were obtained by linear interpolation between and extrapolation from the 1951 and 1961 decennial Census data, increased the published estimates by a virtually constant factor throughout the entire period and thus had no effect on the latter when expressed in index form as in Table A 1 of Appendix A.

Then, an adjustment was made with respect to the status classification of employed persons. It was known that in household-type surveys there was a tendency towards overstatement of self-employed persons because, for example, the respondent was not aware of the fact that the company owned by the head of the family was incorporated. In order to estimate the extent of such miscoding, a subsample was taken of the March 1962 Labour Force Survey, matched by the Survey of Consumer Finances and other sources, and an attempt made to determine whether the enterprise for which the person worked was incorporated or unincorporated. On the basis of this information, 18.3 per cent of those classified as other than paid workers in the Labour Force Survey (excluding agriculture and fishing) were transferred to the paid workers category. The same adjustment factor was applied in each year throughout the period. Because the number of other than paid workers was increasing less rapidly than that of paid workers, the result of the transfer was a slightly less rapid growth in the index of paid workers.

Chart A shows that the various adjustments to the published Labour Force Survey paid worker series reduced considerably its divergence from the published Employment Survey.

The Employment Survey indexes for each industry division were similarly scrutinized for possible causes of divergence. The more important of the factors which came to light, and the adjustments which were made to allow for their effect, are described below.

In the first place, it was found from Labour Force Survey tabulations that the number of part-time workers (defined as employed paid workers who usually work less than 35 hours per week) increased considerably during the postwar period. From a study of a subsample of the Labour Force Survey for the week ending June 23, 1962, it was also found that the coverage of part-time workers in the Employment Survey was lower than that of full-time workers (paid workers who worked 35 hours or more per week). This is partly a result of the exclusion from the Employment Survey of casual employees working less than one day a week, and partly because part-time workers are more characteristically employed in smaller establishments which are excluded from the Employment Survey if they have fewer than 15 employees. On the assumption that the coverage ratios brought to light in the study remained unchanged during the entire period under review, the relative increase in part-time workers resulted in a downward bias in the indexes of the Employment Survey.

The adjustment for the understatement of part-time employment by the Employment Survey was carried out as follows: The estimates of part-time workers by industry division were taken from special Labour Force Survey tabulations pertaining to the Septembers of 1953, and 1957 through 1961. The data for the other years were obtained by intrapolation and extrapolation. The estimates for full-time workers were then derived by subtracting the estimates of part-time from the respective paid worker totals. The estimates of part-time and full-time workers in each industry division were then weighted by the coverage ratios referred to above, added up and divided into the original all paid worker figures, to yield combined coverage ratios for all paid workers in each year weighted by the proportions of part-time and full-time workers covered by the Employment Survey. These ratios, which were assumed to represent the annual movements, were then divided into the coverage ratio of the base year for each industry division in order to arrive at the annual adjustment factors which are

shown in Appendix A, Table A 2, under the heading "Percentage adjustments to published index-Part-time". As can be seen, a progressive upward adjustment was required.

Another adjustment was required as a result of the exclusion of small establishments from the coverage of the Employment Survey. Since the proportion of small establishments varies from industry to industry, the industrial composite index will be affected if the growth trends in industries characterized by large establishments, hence mostly covered by the Employment Survey, are different from those in industries having many small establishments, the coverage of which is therefore relatively low. For instance, in transportation, the railway industry with its declining employment enjoyed virtually complete coverage, while the truck transport industry in which employment is increasing had, as the following table shows, only partial coverage:

Coverage and Growth of Selected Industries in Transportation

	Railway transport	Truck transport
Number of employed wage earners:		
Employment Survey, last pay period in May 1961 as per cent of decennial Census, June 1, 1961	94.5	50.9
Employment Survey index (1949 = 100):		
Annual average, 1961	83.4	220.8

It was therefore necessary to reweight the Employment Survey industrial composite index so as to give proper recognition to the varying rates of change of its component elements. Within industry divisions, reweighting was generally carried out at the major group or 2-digit level of the 1948 Standard Industrial Classification on the basis of 1951 decennial Census data. The transportation, storage and communication industry division, however, was reweighted at the individual industry or 3-digit level because the use of 3-digit as against 2-digit weights gave results as much as 6% higher in the more recent years. In this case, the average of 1951 and 1961 Census weights was used. Reweighted indexes were not prepared for the forestry, construction and service industry divisions.

Between industry divisions, reweighting could conceivably have been also done on the basis of 1951 or 1961 decennial Census weights, or an average of the two. In fact, it was based on the 1962 complete-coverage Employment Survey estimates, since it seemed conceptually preferable to base the calculations as much as possible on Employment Survey data. In any case, the results of reweighting alternatively on the basis of decennial Census data proved to be virtually identical. Table A 2 in Appendix A shows the percentage adjustments to the published Employment Survey composite index as a result of reweighting.

Thirdly, the Employment Survey is a payroll count which is affected by turnover. The establishments covered by the survey report the number of employees on the payroll during the last pay period of each month. The payroll count misstates average employment if hirings and separations take place during this period. If the pattern of hirings and separations and the average length of the pay period remained constant, the employment indexes would not be affected, but changes in these factors impart a degree of error to the indexes.

In order to estimate the effect of turnover, detailed Employment Survey tabulations of employment by type of pay period for each industry division in October 1961 were compared with similar data for October 1953. The study indicated that there had been a slight decrease in the average length of the pay period between 1953 and 1961. By interpolation and extrapolation techniques, estimates of the average length of the pay period were then derived for the remaining years of the period in question.

Next, measures of change in the pattern of hirings and separations by industry were constructed from the data of the relevant DBS survey.[19] After making allowance for the decrease in the average length of the pay period, a set of adjustment factors resulted, the effect of which at the overall level is shown in Table A 2 of Appendix A.

Together, the preceding three adjustments accounted for the major part of the difference between the published and adjusted Employment Survey industrial composite indexes. Several further adjustments were also made which, while not individually of great quantitative importance, seemed equally desirable on conceptual and practical grounds.

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[19] Dominion Bureau of Statistics. *Hiring and Separation Rates in Certain Industries.* Ottawa, Queen's Printer, Semi-annual (DBS Catalogue No. 72-006).

The most important of these minor adjustments was made to allow for the effect of the procedure used in the Employment Survey in handling establishments falling below the 15 employee cut-off limit. If the base year employment of such an establishment was much larger than its current employment, it was left in the base. On the other hand, when an establishment grew above the level of 15 employees, its base year employment was added. The purpose of this procedure was to reflect monthly employment movements more accurately but it biassed the long-run trend. An adjustment was therefore made to the base year universe.

An adjustment also arose out of the fact that the 1949 weight base for establishments in the Employment Survey did not correspond to the calendar year. For the labour input estimates, the base year paid worker employment figures were therefore converted to the calendar year basis. A further adjustment was needed because, up to June 1953, the Employment Survey indexes were calculated with 1939 as base year and excluded Newfoundland. In the revision of the Employment Survey (to 1949 base), Newfoundland was included in the published estimates. Therefore, it was necessary to embody it for the period 1949 to June 1953. Finally, an adjustment was carried out in order to refine the annual average indexes of the Employment Survey. Published annual indexes for the earlier part of the period were derived by averaging published monthly indexes. More recently, they have been calculated by means of the annual averages of the actual employment data. For the purposes of this report, the latter procedure was applied throughout the entire period.

The total influence of the minor adjustments described above is shown in Table A 2 of Appendix A, under the heading of "Other technical factors". The adjustment to allow for the inclusion of fishing in the coverage of the industrial composite index did not have a measurable effect. The adjusted index shown in this table was derived by converting the adjusted Employment Survey indexes for each industry division to absolute numbers on the basis of the 1962 complete-coverage Employment Survey bench-marks previously referred to, then summing the industry figures and reconverting their total into index form.

As a result of all the adjustments discussed, the adjusted Employment Survey index came very close to the adjusted Labour Force Survey paid worker index (see Chart A). The remaining gap could not, however, be closed by further refinements to the two basic series. It thus remained to select the most appropriate paid worker measure for each industry division, to derive the aggregate labour input measure for use in the productivity indexes.

(2) Selection of the Best Paid Worker Measure for each Industry Division

The general criteria used in the selection for each industry division of the paid worker measure best suited for incorporation in the denominator of aggregate productivity ratios included the following:

The measure should originate from the same source, or the same kind of source, as the output data, e.g. an industrial census or an establishment survey. It should approximate the coverage of the output measures. It should be consistent with the statistics chosen for other industry divisions. It should, if possible, be confirmed by other independent sources and, in general, its relative statistical strengths and weaknesses should make it clearly preferable to other alternative choices.

The sources of paid worker estimates considered preferable for productivity purposes are listed below:

Employment Survey (as adjusted)

Forestry
Transportation, storage and communication
Public utility operations
Finance, insurance and real estate

Average of Adjusted Employment Survey and Adjusted Labour Force Survey

Construction

Adjusted Employment Survey and 1951 - 61 Decennial Censuses

Trade
Service

Census of Industry (as adjusted)

Manufacturing
Mining, quarrying and oil wells

Labour Force Survey (as adjusted)

Fishing and trapping

As can be seen above, adjusted Employment Survey indexes were used for most industry divisions. For forestry and public utility operations, the year-to-year movements were generally confirmed by the Labour Force Survey.

For the construction industry, the adjusted Employment Survey and adjusted Labour Force Survey paid worker indexes were very close to each other and, since no clear preference could be given to either source, an average of the two was used.

For trade and service, the adjusted Employment Survey indexes needed further adjustments to trend, in order to eliminate shortcomings due to the relatively low coverage of these industry divisions. This meant that, while the adjusted Employment Survey index was accepted to represent the short-term movements of the number of paid workers, the long-term trend in these two industry divisions was based on the 1951 and 1961 decennial Censuses. In the case of trade, the adjustment consisted of corrections based on changes of employed wage-earners as shown in the 1951 and 1961 decennial Censuses. These were first adjusted for the influence of seasonal factors, in order to arrive at annual averages. In the service industry division the

same trend adjustment was applied, but first the Censuses were adapted to the coverage of the commercial industries.

For manufacturing and mining, the annual Censuses were preferable as they are also the sources of the respective output estimates, although both of these indexes are also corroborated by the revised Employment Survey indexes. The turnover adjustment described earlier in this report has been made to both Census series, and for manufacturing a minor adjustment for part-time workers was also applied in the manner described earlier.

In manufacturing, the production and related worker group plus the administrative and office category provided the paid worker indexes after adjustments were made for turnover, part-time workers and some minor problems.

For the mining industry, two other significant adjustments were carried out to improve the published series for productivity purposes. First, "employees not at mine or plant" which were excluded from the published data, were added. In 1959, the latest Census year on the 1948 Standard Industrial Classification basis, these amounted to 8.9 per cent of paid workers. Secondly, the contract drilling for petroleum and other contract drilling industries, which were excluded from the published mining data due to statistical deficiencies in the basic data, were added to the mining employment, thus increasing the paid worker employment by 5.7 per cent in 1959. Finally, apart from some minor adjustments, the self-employed, as estimated from the Labour Force Survey, had to be subtracted from the mining employment figures to yield a paid worker total.

Starting with 1960, both of these industries were placed on the basis of the new Standard Industrial Classification and, beginning with the 1961 Census of Industry, the new "establishment concept" was introduced in place of the old "activity concept".[20] This involved confining the coverage of industry "principal statistics" to establishments whose major activity is manufacturing or mining. In the case of manufacturing, both manufacturing and other activities (such as trade or construction) are now covered, although manufacturing is still collected and compiled separately. Previously, manufacturing activity only was compiled and the coverage was entended to all units engaged in manufacturing whether or not it was the major activity.

Since neither the real output series nor the Employment Survey indexes used in the aggregate productivity indexes have yet been converted to the 1960 Standard Industrial Classification, the labour input series originating from the Census of Industry were also held on the basis of the 1948 Standard Industrial Classification. The most suitable way of achieving this was by representing the movement of paid worker employment in manufacturing and mining after 1959 by the revised Employment Survey indexes, linked to the adjusted Census of Industry paid worker indexes for the earlier period.

Finally, for the fishing industry, the paid workers index was obtained from adjusted Labour Force Survey estimates, which were the only source available for this industry.

When the above paid worker indexes are aggregated for the commercial nonagricultural economy, they yield the index illustrated by the middle line in Chart A, page 39. Its position between and close to the revised Labour Force Survey index and the revised Employment Survey index would appear to confirm the suitability of the methods used.

(3) Inclusion of Other Than Paid Workers, and Calculation of the Aggregate Labour Input Indexes

Once the best estimates of paid workers were chosen, they had to be combined with those for other than paid workers, in order to yield an index for all persons employed for use in the denominators of the aggregate productivity ratios.

First, the paid worker indexes chosen for each industry division were converted to absolute numbers on the basis of 1962 bench-marks of annual average employment estimates from the new complete-coverage Employment Survey. A test calculation of these series on the alternative bases of 1951 and 1961 decennial Census bench-marks gave virtually identical results. The bench-mark for the fishing industry was the 1961 decennial Census.

Estimates of other than paid workers by industry division were then obtained from the Labour Force Survey. After the adjustments described earlier[21] were applied, the adjusted figures for other than paid workers were added to the numbers of paid workers. The only exception to this general procedure occurred in manufacturing where, since the number of unpaid family workers is very small, the total number in the working owners and partners category was accepted from the Census of Manufactures as representative of other than paid workers.

The absolute figures were then converted into indexes of all persons employed to serve as the employment components of the productivity indexes, as shown in Tables 1, 2 and 3, pages 15-16.

(b) Man-hours

The measurement of productivity changes solely in terms of output per person employed would imply that the unit of measurement of input was invariant over the time period in question. It has already been noted that, in certain circumstances, this will be the appropriate interpretation. In other cases, however, it is desirable to make allowance for the changing time content of the man-year, which is influenced by

[20] For a detailed description of the changes see the feature articles in the May and July 1961 issues of the *Canadian Statistical Review* (DBS Catalogue No. 11-003).

[21] See page 40.

such factors as the long-term trends in standard hours, paid holidays and vacations with pay and by seasonal and cyclical variations from standard hours as well as the changing incidence of part-time employment. It is therefore necessary that the productivity ratios should also be developed in terms of a more fundamental unit of input measurement, the man-hour.

The two basic variations of the man-hour concept are "man-hours paid" and "man-hours worked". In practice, measures of the latter do not conform literally to the concept and might more accurately be described as "man-hours at work" since they generally cover, in addition to the hours actually worked, such activities as commuting within the plant, stand-by and idle time, rest periods, clean-up time and so on. Measures of output per man-hour based on the "man-hours paid" concept reflect the influence of "man-hours not worked but paid" which, as a result of gradual increases in recent years in the number of paid holidays, the length of paid vacations and other paid time off, has become an important factor. When it is desired to emphasize the economic aspects of the productivity relationship, "hours paid" may be the appropriate concept. When the technological nature of the comparison between input and output is being stressed, the "hours worked" concept seems preferable. Statistical limitations at present restrict the use of the former concept.

Ideally, the measures of man-hours worked should be available by industry so that the effects of shifts in employment and in the trends of hours worked as between industries can be distinguished from those of changes in productivity proper within the various industries making up the aggregate. In fact, the available sources do not, without considerable adjustment which is not at present possible, permit the estimation of total man-hours worked for the commercial nonagricultural industries by the aggregation of separate industrial estimates. Thus the denominator of the measures of output per man-hour presented in these reports is derived by direct estimation at the aggregate level.

The only source of "hours worked" data corresponding to the large universe covered by the aggregate productivity indexes is the Labour Force Survey. For the period in question this source provides, at quarterly intervals until 1952 and since then monthly, distributions of total employed by intervals of hours worked. Until April 1961, Labour Force Survey employment was tabulated by seven intervals of hours worked: 0, 1-14, 15-24, 25-34, 35-44, 45-54, and 55 and over. Since that time nine intervals have been used, the 35-44 class having been further broken down into 35-39, 40 and 41-44, but the procedures used in this report for the estimation of average annual hours worked over the entire period covered are based on the seven-interval classification. These data make possible the calculation of a set of average hours worked each year per person employed in the commercial nonagricultural industries which can then be multiplied by the derived aggregate figures of annual average employment to yield the aggregate man-hours worked series. It will be apparent from the previous discussion of the derivation of the aggregate employment series that the Labour Force Survey employment, after coverage adjustment, closely parallels the movements of the derived employment series. The employment distributions of the Labour Force Survey by the seven categories of hours worked can thus be used with confidence for weighting these categories in arriving at a set of average annual hours worked.

At an early stage in the estimation procedure, it was decided to test whether the use of simple arithmetic midpoints of the Labour Force Survey class intervals resulted in any bias in the estimates of average hours worked. Special tabulations by sex and status group were prepared for four representative weeks in 1949 and 1959 which gave a breakdown of the number of workers into 59 intervals and thus made it possible to determine the actual average hours worked for each of the seven classes. It was found that, in both 1949 and 1959, the true midpoints for the intervals up to and including 35-44 hours were generally above the arithmetic midpoints but below in the case of the intervals 45-54 and 55 and over. It was thus established that the use of corrected midpoints would improve the quality of the estimates.

It also became apparent that there was a marked difference between the average hours worked per week by men and women. Furthermore, there proved to be significant differences between the average hours worked by paid workers and other than paid workers, particularly in the 55 hours and over interval.

It was therefore decided to assemble the estimates of average hours worked for the commercial nonagricultural industries by the use of separate data for sex and status group distributions.

The detailed employment distributions for 1949 and 1959 previously referred to also made it possible to study long-term shifts in the weighted midpoints of the various classes. In the 35-44 hour interval, for instance, the average number of hours worked by paid workers declined by approximately one hour. In those cases where the level of the midpoint in an interval had changed significantly, the difference was adjusted by straight line interpolation between 1949 and 1959 and by extrapolation for the other years. For the interval of 35-44 hours, information on hours paid per week in manufacturing by class interval[22] was used in order to adjust for cyclical variations within this important class interval.

The estimation procedure required that a complete set of weighted midpoints by class interval be developed for each month during the period 1947-63.

[22] Data are published at three-yearly intervals in: Dominion Bureau of Statistics. *Earnings and Hours of Work in Manufacturing.* Ottawa, Queen's Printer, Annual (DBS Catalogue No. 72-204).

This made it possible to interpolate weekly figures between the data of survey weeks and thus to secure more refined averages. In order to provide the most realistic basis for this interpolation procedure, it also seemed desirable to recognize the influence of seasonal variations in hours worked. Study of the detailed 1959 data indicated that this was an important factor at the extremes of the distribution, for instance, in the 55 and over interval for all status groups, both male and female, as well as for female paid workers up to 34 hours per week and male other than paid workers from 15 to 34 hours per week. Appropriate adjustments were therefore made.

Up to this point no recognition has been given to the effects of statutory and other holidays on average hours worked. The most important effect of a holiday during a survey week is to shift a portion of the workers in the 35-44 group to the 25-34 group, thus reducing the grand average of hours worked during the week, the size of the reduction depending on the holiday in question. Thanksgiving Day, for example, results in a greater decrease in the grand average than does Remembrance Day. A set of adjustment factors was, therefore, worked out to summarize the average effect of "major" and "minor" holidays for utilization as follows:

For each year, the total hours worked in each survey week as reported in the Labour Force Survey were summed by status and sex groups. Where a holiday occurred in a survey week, the total hours worked were adjusted in such a way as to remove the effects of holiday observance. This was necessary in order to provide an accurate basis for the interpolation of total hours worked in nonsurvey weeks. The holiday adjustment factors were then applied to reduce to the proper level the hours of those weeks, both survey and nonsurvey, in which one or the other kind of holiday occurred.

The practice of interpolation between survey weeks also made it necessary to apply a correction in respect of vacations. Reported employment for the July and August survey weeks is assumed to reflect correctly the incidence of vacations, but when the total man-hours worked of those weeks are used as a basis for weekly interpolation to the figure of the June and September survey weeks, the effect is to understate man-hours worked during the latter part of June and the first part of September which are presumed to be considerably less affected. Thus for the weeks in question, a special adjustment was made to put them on a more normal basis.

It only remained then to make an adjustment for the number of man-hours lost due to strikes and lockouts. The source for this adjustment was *The Labour Gazette*[23] which publishes the number of man-days lost each month on this account. It was assumed that the Labour Force Survey reflects correctly the effects of strikes in progress during the survey week and adjustments were made to the estimated man-hours for nonsurvey weeks in all months with a significant loss of time due to strikes.

To summarize, Labour Force Survey employment distributions were multiplied by the weighted midpoints of the corresponding class intervals in each survey week by sex group and summed to totals for paid workers and other than paid workers respectively. After interpolation between survey weeks and making the appropriate adjustments for holidays, vacations and strikes, annual totals of man-hours worked were obtained. Then, by parallel procedures, corresponding series of annual average employment were obtained, and it only remained to divide the latter into the total man-hours worked year by year to derive a twin series of annual average hours worked by "paid workers" and "other than paid workers" in the commercial nonagricultural industries. These were then multiplied by the adjusted employment figures of "paid workers" and "other than paid workers" respectively, the development of which was described in the preceding section, added and converted to index form for use as the "Man-hours" series of Table 1.

In order to develop a series of average annual hours worked in manufacturing, Census of Manufactures data were used primarily since the Labour Force Survey does not provide sufficient industrial detail. In brief, the procedure followed was to divide the published Census of Manufactures payroll by the average hourly earnings in manufacturing so as to derive an annual series of total hours paid for paid workers. The procedure was carried out separately for the payroll of administrative and office employees and production and related workers by means of the published average hourly earnings of wage-earners and salaried employees respectively.[24]

The hours paid series was converted to hours worked on the basis of the ratio of man-hours not worked but paid to total man-hours paid of production and related workers as reported to the Census of Manufactures between 1956 and 1961. A further adjustment was made to correct the ratio for the more liberal paid leave privileges of administrative and office employees. The corrected ratio was then extrapolated back to 1947 on a fairly conservative basis since it seemed unlikely that the observed increases of the ratio between 1956 and 1961 were part of a linear trend. Independent published material from which to check the validity of these procedures is unfortunately nonexistent. The resultant hours worked series was then divided by the published Census employment series, yielding a series of average hours worked by full-time paid workers in manufacturing which was then multiplied

[23] Official Journal of the Department of Labour, Canada.

[24] Dominion Bureau of Statistics. *Review of Man-hours and Hourly Earnings with Average Weekly Wages.* Ottawa, Queen's Printer, Annual (DBS Catalogue No. 72-202) and Dominion Bureau of Statistics. *Earnings and Hours of Work in Manufacturing.* Ottawa, Queen's Printer, Annual (DBS Catalogue No. 72-204).

by the full-time component of the adjusted employment estimate for paid workers in manufacturing previously referred to.

The estimation of hours worked for part-time workers and working owners and partners in manufacturing was based on the Labour Force Survey hours worked estimates for these classes in the commercial nonagricultural industries, adjusted on the basis of 1959 data for manufacturing so as to allow for the difference in the number of hours worked at the two levels of aggregation. The total number of estimated hours worked in manufacturing was obtained by summing the totals of full-time and part-time paid workers and working owners and partners.

The resultant total hours worked each year in manufacturing were then deducted from the total hours worked each year in the commercial non-agricultural industries to provide a residual series for the nonmanufacturing industries. After conversion to index form, these are used as the "Man-hours" series of Tables 2 and 3 respectively.

APPENDIX A

TABLES SHOWING ADJUSTMENTS
TO PRIMARY LABOUR INPUT DATA

TABLE A 1. Adjustments to the Published Labour Force Survey Paid Worker Estimates Nonagricultural Industries, Canada, 1947 - 63

Year	Percentage adjustments to index based on published data			
	Published estimates[1] (converted to index, 1949=100)	Adjustment to the coverage of the commercial sector	Coding adjustment between self-employed and paid workers	Adjusted estimates (converted to index, 1949=100)
1947	93.9	– 0.6	+ 0.2	93.6
1948	96.3	– 0.2	+ 0.1	96.2
1949	100.0	—	—	100.0
1950	101.6	– 1.0	– 0.1	100.4
1951	107.8	– 0.5	– 0.3	107.0
1952	111.6	– 0.2	– 0.4	111.0
1953	114.4	– 0.7	– 0.4	113.0
1954	114.3	– 1.7	– 0.4	111.9
1955	119.9	– 1.6	– 0.5	117.3
1956	127.6	– 1.3	– 0.6	125.1
1957	132.2	– 1.5	– 0.6	129.2
1958	132.6	– 2.7	– 0.7	128.0
1959	137.4	– 4.1	– 0.7	130.9
1960	140.7	– 5.8	– 0.7	131.7
1961	142.9	– 6.9	– 0.7	132.2
1962	148.2	– 7.3	– 0.7	136.4
1963	152.8	– 7.1	– 0.8	140.9

[1] Revised to include Newfoundland in base year.

TABLE A 2. Adjustments to the Published Employment Survey Industrial Composite Index Canada, 1947 - 63

Year	Published Employment Survey index (1949=100)	Percentage adjustments to published index				Adjusted Employment Survey index (1949=100)
		Reweighting	Turnover	Part-time	Other technical factors	
1947	95.7	– 0.6	– 0.6	– 0.1	+ 0.4	94.8
1948	99.7	– 0.2	– 0.3	– 0.1	+ 0.1	99.2
1949	100.0	—	—	—	—	100.0
1950	102.1	+ 0.2	+ 0.2	+ 0.1	+ 0.2	103.0
1951	109.1	+ 0.1	—	+ 0.3	+ 0.2	109.7
1952	111.9	+ 0.5	+ 0.2	+ 0.4	+ 0.4	113.6
1953	113.1	+ 0.1	+ 0.3	+ 0.5	+ 0.7	115.0
1954	109.9	+ 0.8	+ 0.5	+ 0.7	+ 0.7	112.9
1955	112.9	+ 1.0	+ 0.6	+ 0.9	+ 0.8	116.6
1956	120.7	+ 1.2	+ 0.4	+ 1.0	+ 0.8	124.9
1957	122.6	+ 1.6	+ 0.4	+ 1.1	+ 1.0	127.8
1958	117.9	+ 2.1	+ 0.8	+ 1.1	+ 1.2	124.1
1959	119.7	+ 2.3	+ 0.8	+ 1.3	+ 1.3	126.7
1960	118.7	+ 2.7	+ 0.8	+ 1.4	+ 1.4	126.4
1961	118.1	+ 2.8	+ 1.0	+ 1.7	+ 1.7	126.9
1962	121.5	+ 2.7	+ 1.0	+ 1.9	+ 1.8	130.8
1963	124.6	+ 3.0	+ 1.0	+ 1.9	+ 1.9	134.7

APPENDIX B

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