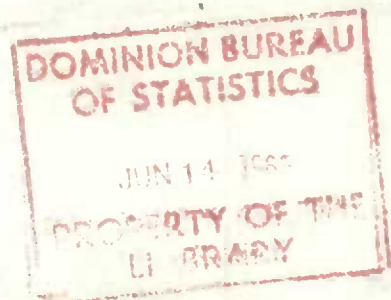INTERNAL DRAFT

INDEXES OF OUTPUT PER PERSON EMPLOYED

AND PER MAN-HOUR IN THE

SYNTHETIC TEXTILE MILLS INDUSTRY

1947-61

DOMINION BUREAU OF STATISTICS

INDUSTRY DIVISION

PRODUCTIVITY RESEARCH AND ANALYSIS SECTION

1965

NOTE

It is noted here that the term "persons employed", when used in this report, represents paid workers plus working owners and partners engaged in the production of output. This is in contrast to the definition used for the same term in the Bureau's aggregate productivity study (Indexes of Output per Person Employed and per Man-hour in Canada, Commercial Nonagricultural Industries, 1947-63, DBS Catalogue No. 14-501), where unpaid family workers are included. In addition, in the latter, employment is presented at the total level only, whereas in this report a distinction is made between production and related workers and administrative and office employees.

SYMBOLS

The interpretation of the symbols used in the tables throughout this publication is as follows:

　　　.. figures not available.

　　　... figures not appropriate or not applicable.

　　　- nil or zero.

　　　-- amount too small to be expressed.

FOREWORD

This publication is the first in a new series of manufacturing industry studies undertaken by the Dominion Bureau of Statistics in response to demands from a wide variety of sources. Industry, labour and government, as well as private researchers and international organizations, have for a long time recognized that productivity measures, expressed as volume ratios between output and one or more of the inputs used in its production, could provide useful yardsticks of change in the overall effectiveness of the productive process, whether for the individual plant or industry, or for the economy as a whole. 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. The interest in questions of economic growth which began to develop in the mid-nineteen fifties gave further emphasis to the need for an official programme of productivity research and analysis, but it was not until quite recently, however, that resources became available with which to pursue the original initiative.

First priority was given to the development of overall productivity measures, and in this connection the Dominion Bureau of Statistics has recently prepared a set of indexes of real output per unit of labour input for the commercial nonagricultural industries and the manufacturing and nonmanufacturing components of this universe. These indexes will be kept up-to-date and it is hoped that further detail can be provided at the industrial division level and that they can be extended to include agriculture. The need for productivity measures relating to individual industries is, however, hardly less compelling, particularly in view of current interest in problems relating to secondary manufacturing industries. By bringing to light some of the divergent trends which underlie the movements of the economy wide estimates, it is hoped that this series of reports will contribute to the improvement of analysis and policy formulation at all levels of aggregation.

In particular, time series indexes of productivity by industry will provide standards of reference with which the performance of individual establishments within the industry can be compared. Also, by permitting comparisons between similarly constituted industries, they should shed light on the structural characteristics of Canadian industry and its international competitiveness. Again, industry productivity measures will provide the basis for more detailed forecasting of such related variables as output, employment, prices and wage rates.

It should be remembered, however, that 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 early publications in this series must be considered as pilot studies, which can be improved with experience and the further development of basic statistical data. It is hoped that comments will be received from users which will enable the Dominion Bureau of Statistics to increase the usefulness of subsequent publications. Bearing in mind the various uses just referred to, the selection of industries for productivity measurement was specifically based on the following criteria: (a) that they be relatively important to the economy as a whole; (b) that they represent a cross section of manufacturing in which import-competing, export and domestic industries are all represented; (c) that there be comparable international productivity statistics, and (d) that the preparation of productivity measures seem statistically feasible.

The measures presented in this report relate output to a single input only, labour time. This is primarily for reasons of the relative ease of measurement, availability of labour data as compared with other types of input and because labour cost is a major element in total production cost. More fundamentally, labour productivity indexes are particularly appropriate in a context where man is, in

Marshall's words, both the end and an agent of production. It must be emphasized, however, that indexes of output per unit of labour input do not measure the unique contribution of labour to production. Changes in such indexes reflect the combined influence of a number of separate though interrelated factors such as the amount and quality of equipment employed, managerial efficiency and technical progress as well as the skill and effort of the labour force.

On the output side, both gross and net measures of real output have been developed. In conjunction with the alternative concepts of labour input which have been used, this makes available a choice of productivity measures for the wide variety of uses to which they can be put.

This study has been prepared in the Industry Division of the Dominion Bureau of Statistics under the general direction of V.R. Berlinguette who participated in the work of the interdepartmental committee previously referred to. I. Bernolak, former Chief of the Productivity Research and Analysis Section of the Industry Division initiated the industry studies programme, which was further developed by D.A. Worton who prepared the present report with the collaboration of M. Lafontaine. The interest and co-operation of other officials of the Bureau is also acknowledged, particularly that of G. J. Garston, Chief of the Industrial Output Section, National Accounts and Balance of Payments Division, and Mr. A. F. Holmes, Statistician, Textile Industries, Industry Division. Mention must also be made of the contribution of various representatives of the Synthetic Textile Mills industry whose advice was extremely valuable and who frequently went to considerable trouble to fill gaps in the data underlying the study.

TABLE OF CONTENTS

PART I

GENERAL DESCRIPTION AND CHARACTERISTICS

OF THE INDUSTRY

PART II

TRENDS AND FLUCTUATIONS IN OUTPUT

PER UNIT OF LABOUR INPUT

PART III

STATISTICAL TABLES AND CHARTS

TABLE OF CONTENTS - Continued

TABLE OF CONTENTS - Continued

PART IV

GENERAL TECHNICAL NOTES

Basic Concepts and Methods

TABLE OF CONTENTS - Concluded

PART V

INDUSTRY TECHNICAL NOTES

APPENDICES

PART I

GENERAL DESCRIPTION AND CHARACTERISTICS

OF THE INDUSTRY

PART I

GENERAL DESCRIPTION AND CHARACTERISTICS OF THE INDUSTRY

Definition and Structure

The Synthetic Textile Mills industry, No. 201 in the (new) 1960 Standard

Industrial Classification, is defined as follows:

"Establishments primarily engaged in manufacturing yarns and broad woven goods of synthetic textile fibres,(1) including glass fibres. This industry includes establishments primarily engaged in manufacturing yarns and broad woven goods of natural silk. It also includes establishments engaged in extrusion of synthetic textile filaments. Establishments primarily engaged in producing the basic synthetic material in such forms as liquids, chips, powders and flakes are classified in Industry No. 373 - Manufacturers of Plastics and Synthetic Resins."(2)

This definition does not differ essentially from the one which prevailed

while the 1948 Standard Industrial Classification was in force, during which time

the industry was known as Synthetic Textiles and Silk. When the revised classifi-

cation was implemented in 1960 in the Census of Manufactures, the manufacturers of

synthetic thread were transferred to the newly established Thread Mills industry

(new S.I.C. No. 212) and two establishments, one formerly classified in the Dyeing

and Finishing of Textiles industry (old S.I.C. No. 261) and the other in the Wool

Yarn industry (old S.I.C. No. 257), were brought in. In addition, as a result of

the implementation of a new definition of reporting units (establishments)(3) in

the Census of Manufactures of 1961, the manufacturing activities of a major fibre

and chemicals producer with an integrated plant at a single location, which had

previously formed the basis of two reports for the Census, one classified to Syn-

thetic Textile Mills and one to the Manufacturers of Industrial Chemicals industry

(new S.I.C. No. 378), were combined in a single report classified to the latter

industry. The net effect of these changes on the principal statistics of the industry

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(1) The term "fibres" as subsequently used in this report refers to continuous filament yarns and various forms of staple fibre.
(2) Dominion Bureau of Statistics, Standard Industrial Classification Manual, 1960, DBS Catalogue No. 12-501.
(3) See Part IV, General Technical Notes, page 94.

was quite small. For instance, the value of shipments declined by less than 2%.(4)

In order to provide the longest possible sequence of comparable data for analytical purposes, the various measures of input and output for 1960 and 1961 have been recompiled in conformity with the 1948 Standard Industrial Classification and the former reporting procedures. Similarly, the 1959 and 1960 data have also been recompiled so as to be fully consistent with those of 1961 which, in the form originally reported, reflect the full impact of the 1960 Standard Industrial Classification and the New Establishment Concept as it applies to manufacturing operations. Thus, for the period 1959 to 1961, two sets of data exist which are referred to in this report as being on "old basis" and "new basis" respectively.(5) Data on both the old and new basis are shown in the tables of Part III, but the description and analysis of Part II, and the charts of Part III which are extensively utilized in the analysis, make use of data calculated on the old basis only.

As the definition indicates, the Synthetic Textile Mills industry embraces three main kinds of manufacturing activity. The first of these, the production of synthetic filament yarns and staple fibre, is essentially chemical in nature while the other two, which consist of the spinning and processing of yarn and the weaving and finishing of fabrics, resemble the conventional textile processes based on natural fibres. With one major exception, these three activities are carried on in separate establishments.(6) In this report, the establishments engaged in the first kind of activity are referred to as "fibre producers", while the others are grouped together as "fibre processors". On the new basis of classification, there were, in 1961, 56 establishments in the industry and, of these, six establishments were primarily fibre producers and the remainder primarily fibre processors.

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(4) See Table 1, Dominion Bureau of Statistics, Synthetic Textile Mills, 1961, DBS Catalogue No. 34-208.
(5) See Part IV, General Technical Notes, page 93.
(6) For a more detailed discussion of this point and other descriptive aspects of the industry, see Tariff Board, Silk and Man-Made Fibres, and Products, Reference No. 125, Ottawa, Queen's Printer, 1959.

Because of the interest which undoubtedly attaches to these distinct branches of the industry, it has seemed desirable, for the purposes of productivity measurement, to calculate separate output and input measures for fibre producers and fibre processors, in addition to those for the industry as a whole. The detailed procedures involved in these additional calculations are described later in this report.(7)

The change in relative importance of the two branches of the industry is illustrated in Table Ia below which shows the percentage share of each in real net output(8) and total employment.

TABLE Ia. Percentage Distribution of Real Net Output and Total Employment, Synthetic Textile Mills: Fibre Producers and Fibre Processors, Canada, Old Basis, 1947-61

Year	Real net output		Total employment	
	Fibre producers	Fibre processors	Fibre producers	Fibre processors
	per cent			
1947	34.9	65.1	22.0	78.0
1948	38.1	61.9	20.5	79.5
1949	36.2	63.8	21.3	78.7
1950	41.6	58.4	22.0	78.0
1951	40.9	59.1	22.5	77.5
1952	46.4	53.6	22.4	77.6
1953	48.7	51.3	23.8	76.2
1954	53.5	46.5	26.9	73.1
1955	52.5	47.5	29.7	70.3
1956	52.2	47.8	31.8	68.2
1957	58.0	42.0	33.4	66.6
1958	57.1	42.9	32.2	67.8
1959	61.4	38.6	35.4	64.6
1960	62.5	37.5	33.9	66.1
1961	56.8	43.2	30.7	69.3

(7) See Part V, Industry Technical Notes, pages 111 and 112.
(8) Roughly, the sum of current year quantities of products valued at 1949 average unit values minus the sum of current year quantities of materials, etc. used at 1949 average unit values. See Part IV, General Technical Notes, pages 73-76 for a more complete explanation.

Apart from the analytical advantages to be derived from a split of the Canadian data, international comparisons are also facilitated, since the Standard Industrial Classifications of other leading producers of synthetic textiles such as the United States, the United Kingdom, Japan and Italy, usually classify the activities embraced by the Canadian definition in more detail. The United States, for instance, normally publishes indexes of output per unit of labour input for the Synthetic Fibres industry,(9) the coverage of which is roughly similar to that of "fibre producers"(10) as defined here.

Growth and Characteristics

As Table Ib shows, on next page, the value in current dollars of factory shipments in the Synthetic Textile Mills industry increased by almost 200% between 1947 and 1961, while for Manufacturing as a whole, the corresponding increase was about 140%. Thus, the share of the Synthetic Textile Mills industry in the Manufacturing total increased by only about 25%. On the other hand, the major group of Textile Industries, of which Synthetic Textile Mills forms a part, increased the value of its shipments by barely 70% between 1947 and 1961. It is thus evident, as the year by year percentages indicate, that the shipments of the Synthetic Textile Mills industry have become a progressively more important part of the overall Textile Industries' aggregate.

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(9) U.S. Department of Labor, Bureau of Labor Statistics, Indexes of Output per Man-hour for Selected Industries, 1939 and 1947-61, Annual Industry Series, Washington, BLS, October 1962, page 28. But in the most recent publication of this series (September 1964), the Synthetic Fibres data are temporarily withdrawn.

(10) BLS industry indexes of output per unit of labour input are in fact based on the output of all products primary to the covered industries, whether or not made by the industry to which they are primary. The relevant 4-digit industries in this case are "2823, Cellulosic Man-Made Fibers" and "2824, Synthetic Organic Fibers, except Cellulosic". The latter does not include glass yarns and fibres.

TABLE 1b. Value of Factory Shipments,(1) Synthetic Textile Mills,
Textile Industries, and Manufacturing, as Originally Reported,
Canada, 1947-61

Year	Synthetic textile mills	Textile industries	Manufacturing	Synthetic textile as per cent of textile industries	Synthetic textile as per cent of manufacturing
	millions of dollars			per cent	
1947	85	515	10,081	16.5	0.8
1948	107	605	11,875	17.7	0.9
1949	124	637	12,480	19.5	1.0
1950	147	741	13,818	19.8	1.1
1951	167	846	16,392	19.7	1.0
1952	158	744	16,983	21.2	0.9
1953	146	701	17,785	20.8	0.8
1954	132	641	17,555	20.6	0.8
1955	159	735	19,514	21.6	0.8
1956	161	767	21,637	21.0	0.7
1957	164	748	22,184	21.9	0.7
1958	177	739	22,163	24.0	0.8
1959	207	803	23,312	25.8	0.9
1960(2)	222	811	23,747	27.4	0.9
1961(3)	249	875	24,243	28.5	1.0

(1) Up to 1952, gross value of products, except Synthetic Textile Mills which started
     reporting shipments in 1953.
(2) New S.I.C. introduced.
(3) New reporting procedures (establishment concept) introduced.
Source: Dominion Bureau of Statistics, General Review of the Manufacturing Industries
     of Canada, Annual, DBS Catalogue No. 31-201.

A qualification must, however, be made which bears importantly on the

validity of the above comparison between the factory shipments of the Synthetic

Textile Mills industry and those of its major group, Textile Industries. Given the

definition of the industry, its shipments reflect elements which have no counterpart

in the major group, in that the former is significantly engaged in the actual pro-

duction of its own fibres, whereas the industries within the major group which use

natural fibres are not. Thus, to the extent that synthetic fibres are made within

the industry, there exists a form of duplication in its shipments which would not

occur if these fibres were procured from sources external to the industry. Such

intra-industry shipments are netted out in measures of value added in manufacturing

operations, so that the comparisons of value addéd between Synthetic Textile Mills

and the Textile Industries major group for the period 1947-61, shown in Table Ic

below, probably provide a more basic indication of the relative importance of the

industry.

TABLE Ic. Value Added in Manufacturing Operations, Synthetic Textile Mills
and Textile Industries, as Originally Reported, Canada, 1947-61

Year	Synthetic textile mills	Textile industries	Synthetic textiles as per cent of textile industries
	millions of dollars		per cent
1947	50	215	23.3
1948	63	262	24.0
1949	76	286	26.6
1950	88	316	27.8
1951	96	338	28.4
1952	90	313	28.8
1953	79	299	26.4
1954	70	275	25.5
1955	86	315	27.3
1956	80	324	24.7
1957	85	331	25.7
1958	87	323	26.9
1959	107	364	29.4
1960(1)	116	369	31.4
1961(2)	123	393	31.3

(1) New S.I.C. introduced.
(2) New reporting procedures (establishment concept) introduced.
Source: Dominion Bureau of Statistics, General Review of the Manufacturing Industries
of Canada, Annual, DBS Catalogue No. 31-201.

This comparison shows that while the relative importance of Synthetic

Textile Mills within the Textile Industries major group was consistently higher than

when figured on the factory shipments basis, the overall increase in relative im-

portance between 1947 and 1961 was not nearly so great. Furthermore, while the year-

to-year changes in the percentage relationship between the Synthetic Textile figures

and those of the major group were generally in the same direction on both basis of comparison, the magnitude of the decreases from 1952-53, 1953-54 and 1955-56 were greater in the case of value added. In effect, the relative importance of Synthetic Textile Mills remained static between 1952 and 1956 on the basis of factory shipments, whereas it decreased appreciably on the basis of value added.

Using the number of persons employed as a criterion of the relative growth of the Synthetic Textile Mills industry, the previous picture is modified somewhat. In the first place, overall changes between 1947 and 1961, as shown in Table Id below, were quite small. The number of persons employed in manufacturing operations in

TABLE Id. Number of Persons Employed in Manufacturing Operations,
Synthetic Textile Mills, Textile Industries, and Manufacturing,
as Originally Reported, Canada, 1947-61

Year	Synthetic textile mills	Textile industries	Manufacturing	Synthetic textile as per cent of textile industries	Synthetic textile as per cent of manufacturing
		number		per cent	
1947	14,728	73,979	1,131,750	19.9	1.3
1948	16,097	75,816	1,155,721	21.2	1.4
1949	16,828	77,773	1,171,207	21.6	1.4
1950	17,955	80,328	1,183,297	22.4	1.5
1951	17,997	81,710	1,258,375	22.0	1.4
1952	15,723	72,739	1,288,382	21.6	1.2
1953	15,723	73,190	1,327,451	21.5	1.2
1954	13,662	64,581	1,267,966	21.2	1.1
1955	15,408	69,144	1,298,461	22.3	1.2
1956	15,694	70,873	1,353,020	22.1	1.2
1957	15,251	68,512	1,359,061	22.3	1.1
1958	14,436	63,472	1,289,602	22.7	1.1
1959	15,004	63,579	1,303,956	23.6	1.2
1960(1)	15,101	61,756	1,294,629	24.5	1.2
1961(2)	15,849	62,544	1,264,946	25.3	1.3

(1) New S.I.C. introduced.
(2) New reporting procedures (establishment concept) introduced.
Source: Dominion Bureau of Statistics, General Review of the Manufacturing Industries of Canada, Annual, DBS Catalogue No. 31-201.

Synthetic Textile Mills and in Manufacturing increased by about 8% and 12% respectively, so that the share of the former in the Manufacturing total decreased very slightly, although this does not show in the calculated percentages due to rounding. In the Textile Industries major group, the number of persons employed actually decreased by about 16%, with the result that the relative share of Synthetic Textile Mills within this aggregate increased from 19.9% to 25.3%, i.e. by roughly 27%.

Thus, by any token, the postwar growth of the Synthetic Textile Mills industry has been more pronounced than that of the Textile Industries major group, and there can be little doubt that this is the result of certain advantages which are unique to it. In all textile operations the characteristics of the end product, such as resistance to wear, shrinkage, pilling or creasing, the type of finish, weight in relationship to bulk, etc., are ultimately dependent on the mechanical properties of the basic fibres involved. Since synthetic fibres can literally be made to order from basic molecular building blocks these mechanical characteristics can be varied almost at will, and this gives them a versatility which is limited only by the ability to translate into commercially feasible processes the possibilities which are continously being opened up by the research chemist. Ironically, the fibre which laid the basis for the development of the Synthetic Textile Mills industry, viz. rayon, is not a genuine synthetic. Vegetable fibres such as cotton, linen and jute are composed essentially of cellulose fibres and the development of "artificial silk", as rayon often used to be called,(11) followed the development of methods by which this fibre-producing substance could be cheaply produced from woodpulp.

The true synthetics(12) resulted from the discovery that fibre-producing substances other than cellulose could be synthesized from intermediate chemicals,

(11) Before 1947, the name of the industry was "Artificial and Real Silk Goods".
(12) As an all-embracing description of both cellulosic and synthetic fibres, the
     term "man-made fibres" seems to be gaining some acceptance.

mostly by the process of polymerization, i.e. the building of molecular chains. Most of these intermediates, e.g. those used for nylon, terylene and orlon, are hydrocarbons, a family of petroleum derivatives. The development of this group of synthetics probably derived its first impetus from military demands in World War II, but civilian demands quickly made themselves felt after the end of hostilities and, since then, their importance, relative to the various rayon products, has steadily increased. However, far from their being eclipsed, the absolute importance of rayon products continues to grow.

As a result of these developments, it is extremely difficult to summarize statistically the changes which took place in the composition of the output of the Synthetic Textile Mills industry during the period in question. In Table Ie below, which shows the distribution of shipments in 1947 and 1961 between the various kinds of product, more detailed comparisons are not possible, because frequent changes in reporting requirements, which were designed to show the current pattern as clearly as possible, have affected the continuity of product detail, particularly in the area of woven fabrics. Furthermore, much of the continuous detail which is available cannot be disclosed because of its confidential nature. Nevertheless, with the aid of some supplementary comments, the table conveys a clear impression of the changes in the composition of output between 1947 and 1961.

TABLE Ie. Distribution of Factory Shipments(1) by Principal Products, Synthetic Textile Mills, Old Basis, Canada, 1947 and 1961

Products	1947		1961	
	$'000	%	$'000	%
Woven fabrics	52,100	61.4	81,185	32.1
Knitted fabrics	--	--	3,950	1.6
Total fabrics	52,100	61.4	85,135	33.7
Yarn and fibre:				
Synthetic singles (including tire yarn)	16,452	19.4	73,284	29.0
Thrown yarn	6,594	7.8	11,079	4.4
Spun rayon yarn (including mixtures)	2,722	3.2	4,895	1.9
All other yarns and thread(2)	1,661	2.0	17,321	6.9
Staple fibre and tow	--	--	22,327	8.8
Total yarn and fibre	27,429	32.3	128,906	51.0
All other products	2,989	3.5	37,111	14.7
Custom and commission work	2,352	2.8	1,377	0.5
Total shipments	84,870	100.0	252,529	100.0

Figures may not add due to rounding.
(1) In 1947, value of production.
(2) Thread, 1947 only. In 1947, total also includes knitted fabrics and staple fibre and tow, data for which were confidential.

The broad impression of a relative shift from woven fabrics to yarns and staple, which these figures convey, is similar to that of the real net output data of Table Ia which illustrated the growth in relative importance of the fibre producing branch of the industry. In 1947, only three establishments were engaged in the production of synthetic fibres. One of these was integrated, so that part of its fibre output does not appear directly in the preceding table. It has been estimated elsewhere(13) that in 1947, these producers accounted for some 60% by weight of the fibres used in Canada. As existing establishments increased their capacity and output and new ones came into the market, this percentage was progressively increased and a small percentage of total production began to be exported.

By 1961, not only had the volume of production of man-made fibres increased substantially but also the variety, with glass, polyvinylidene chloride, polyester and acrylic fibres all being well established supplements and competitors of nylon and the cellulosics. As well as meeting a greater portion of the requirements of the domestic textile industry, significant quantities of output were also flowing into other industrial uses such as tire manufacture and the production of cigarette filters.

Although "all other products" is a residual category, and no value figures can be shown in detail, mention may be made of certain commodities which were not shipped at all in 1947 but which had grown substantially in importance by 1961. These included consumer products such as carpets and blankets, various kinds of building material and intermediate chemicals for the manufacture of nylon and polyester fibres for which there exists an export demand.

In terms of fabric construction, rayon still remained the most important basic fibre in 1961, but its relative importance had declined substantially since 1947, while nylon, polyester and the acrylic fibres experienced proportionate increases.

(13) Tariff Board, op. cit., pages 49-61.

In contrast to the situation with fibres, the available data(14) seem to indicate that exports of fabricated products comprised a much smaller proportion of total shipments during the period in question and that the percentage of the domestic market served by imports tended to increase.

(14) Tariff Board, op. cit., pages 49-61.

TABLE If. Selected Statistics of Component Establishments, Classified
by Number of Persons Employed in Manufacturing Operations,(1)
Synthetic Textile Mills, as Originally Reported,
Canada, 1947, 1956 and 1961

Item		Persons employed			
		Total	0-99	100-499	500 and over
			per cent		
Establishments	1947	100.0	35.1	46.0	18.9
	1956	100.0	48.9	37.8	13.3
	1961	100.0	48.1	36.5	15.4
Persons employed(2)	1947	100.0	4.6	25.5	69.9
	1956	100.0	7.4	27.3	65.3
	1961	100.0	8.3	29.2	62.5
Salaries and wages(2)	1947	100.0	4.5	22.7	72.8
	1956	100.0	6.7	24.8	68.5
	1961	100.0	7.3	26.3	66.4
Gross value of production	1947	100.0	4.1	25.1	70.8
	1956	100.0	8.1	23.8	68.1
	1961	100.0	8.9	30.5	60.6
Cost of materials used ...	1947	100.0	4.3	36.9	58.8
	1956	100.0	9.6	29.9	60.5
	1961	100.0	11.0	38.8	50.2
Value added by manufacture	1947	100.0	4.0	17.9	78.1
	1956	100.0	6.8	18.3	74.9
	1961	100.0	6.9	23.1	70.0
		dollars			
Value added per	1947	3,471	3,007	2,434	3,879
person employed	1956	5,458	5,001	3,661	6,260
	1961	8,307	6,978	6,568	9,294

(1) Sometimes the data for two separate establishments are combined in a single
report for Census purposes. Such combinations are treated as single establish-
ments in this table.
(2) Excludes persons employed in separate head offices.

Size and Location of Establishments

For the purpose of commenting on changes in the size structure of the Synthetic Textile Mills industry between 1947 and 1961, percentage distributions of certain principal statistics for the years 1947, 1956 and 1961 by establishment size group (based on the number of persons employed) are shown in Table If on previous page.(15) Attention is also drawn to Tables 3 and 4 of Part III in which a broader selection of summary statistics for the entire period from 1947 to 1961 is presented.

In broad outline, the size structure of the industry underwent no drastic change between 1947 and 1961. The increase in the reported number of establishments, from 40 to 56, was mostly concentrated in the 0-99 size group, thereby increasing the importance of the latter in percentage terms. Nevertheless, in all three years, the relatively small number of establishments which employed 500 persons or more consistently accounted for major portions of the gross value of production and value added of the industry.

Another major impression which emerges from Table If is that there was, for the industry as a whole, no simple relationship between the size of establishment and the level of value added per person employed. For instance, in each of the three years, value added per person employed is lower in the 100-499 size group than in the 0-99 size group, but higher in the 500 and over size group than in either of the other two.

A more revealing comparison could have been made by breaking down the establishments within each size group into the three categories of fibre producers, spinners and throwsters, and weavers and finishers, since the level of value added varies considerably between categories and between size groups within categories.

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(15) Since 1961 the processing of Census of Manufactures principal statistics has
     been on a computer basis. A number of analytical ratios, also classified by
     establishment size group on the basis of persons employed, have been made
     available as a by-product of the computer runs. The availability of these data
     in future reports is expected to enhance considerably their description and
     analytical usefulness.

Again the distribution of the three types of establishment also varies between size groups. For instance, the level of value added per person employed in fibre producing establishments in 1961 tended to increase as the size of establishment increased and was, on the average, about twice as high as in the other two categories. On the other hand, the level of value added per person employed in spinning and throwing and in weaving and finishing establishments apparently decreased as the size of establishment increased. However, a detailed discussion of these points would have involved the disclosure of confidential information.

As Table Ig indicates, the majority of the establishments in the Synthetic Textile Mills industry in both 1947 and 1961 were located in Quebec, the remainder,

TABLE Ig. Number of Establishments, Persons Employed and Value of Shipments by Province, Synthetic Textile Mills, as Originally Reported, Canada, 1947 and 1961

Province	Establishments		Persons employed in manufacturing operations		Value of shipments(1)	
	No.	%	No.	%	$'000,000	%
1947						
Canada	40	100.0	14,728	100.0	85	100.0
Quebec	30	75.0	10,388	70.5	57	67.1
Ontario and New Brunswick	10	25.0	4,340	29.5	28	32.9
1961						
Canada	56	100.0	15,849	100.0	249	100.0
Quebec	38	67.9	10,526	66.4	133	53.4
Ontario and Alberta	18	32.1	5,323	33.6	116	46.6

(1) In 1947, gross value of products.
Source: Dominion Bureau of Statistics, Synthetic Textile Mills, Annual, DBS Catalogue No. 34-208.

with one exception in each year, being located in Ontario. Between 1947 and 1961,
however, there was a relative shift from Quebec to Ontario and the other provinces
in the number of establishments, the employment and value of shipments for which they
accounted. The shift was particularly pronounced in the case of value of shipments,
and was undoubtedly the result of the relatively faster growth of the fibre producing
establishments, all but one of which are located outside Quebec.

Employment, Hours of Work and Remuneration of Labour

For the comparisons that follow, the relevant data are mostly drawn from
the "Review of Man-hours and Hourly Earnings"(16) and "Earnings and Hours of Work in
Manufacturing"(17) which provide a common source of labour statistics for the Syn-
thetic Textile Mills industry, Textile Industries and Manufacturing. In Table 4 of
Par 111, a broader selection of labour statistics is presented for the Synthetic
Textile Mills industry alone.

Employment and Hours of Work - Overall changes in employment in the Synthetic Textile
Mills industry during the period under review have already been noted in the course
of describing its growth relative to that of the Textiles major group and Manufactur-
ing as a whole. The changes which occurred in the composition of this employment,
as between production and related workers and administrative and office employees,
are now summarized for the three levels of aggregation under discussion.(18) In
all three cases, the ratio of administrative and office to persons employed increased
between 1947 and 1961. However, the increase from 11.0% to 23.1% in the ratio for
the Synthetic Textile Mills industry was larger than that for Textile Industries

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(16) Dominion Bureau of Statistics, Review of Man-hours and Hourly Earnings, DBS
     Catalogue No. 72-202.
(17) Dominion Bureau of Statistics, Earnings and Hours of Work in Manufacturing, DBS
     Catalogue No. 72-204.
(18) In this connection, the terms "wage-earner" and "salaried employee" as used in
     the Employment Surveys can be considered roughly synonymous with "production and
     related worker" and "administrative and office employee" respectively as defined
     in the Census of Manufactures.

(11.7% to 19.3%) and that for Manufacturing (16.9% to 23.4%). The increases took
place mostly before 1954 and the ratios have been generally stable since that time.

During the period 1947 to 1961, there was a widespread tendency for the
length of the working week of production and related workers (wage-earners) in the
Manufacturing industries to decline, to which Synthetic Textiles and Silk(19) was
no exception. Average hours paid per week in the latter declined from 44.5 to 43.3,
i.e. by about 2.7%, while the corresponding decrease in the Textile Products major
group was from 43.2 hours to 42.0 hours (2.8%) and in Manufacturing from 42.5 hours
to 40.6 hours (4.5%).

The difference between the absolute levels of the data is noteworthy,
average hours paid of wage-earners in the Synthetic Textiles and Silk industry being
invariably higher than those in Textile Products, which in turn were generally higher
than those in Manufacturing. The limited data for the component branches of Syn-
thetic Textiles and Silk, however, seem to indicate that the averages for all estab-
lishments concealed two quite different levels of activity for wage-earners, with
Spun Yarn and Fabrics (fibre processors) working longer hours than Filament Yarn and
Staple Fibres (fibre producers) where the averages were much closer to those of
Textile Products.

Since 1956, the Census of Manufactures has collected the man-hours worked,
man-hours not worked but paid and total man-hours paid of production and related
workers. Thus, although the period of availability is a relatively short one, these
data do permit a tentative appraisal of the relative rates of growth of man-hours
worked and man-hours paid of production and related workers at the three levels of
aggregation under study. Perhaps the most suitable way in which the contrast can be
drawn is by a comparison of the percentages of man-hours not worked but paid to total

(19) Employment Survey nomenclature is used when the data are drawn from this source.
    The industrial classifications utilized in the Employment Survey do not differ
    materially from those on which the Census of Manufactures data used in this
    report are based.

man-hours paid, shown in Table Ih below.

TABLE Ih. Man-hours not Worked but Paid of Production and Related Workers
as Per cent of Total Man-hours Paid, Synthetic Textile Mills,
Textile Industries and Manufacturing, as Originally Reported,
Canada, 1956-61

Year	Synthetic textile mills	Textile industries	Manufacturing
	per cent		
1956	4.50	5.11	4.69
1957	4.82	5.37	4.93
1958	4.94	5.39(1)	5.10(1)
1959	4.81	5.42(1)	5.28(1)
1960	5.09	5.45	5.47
1961	5.88	5.48	5.75

(1) Interpolated data.

There is no great disparity in the absolute levels of the percentages shown
here. For instance, on the assumption of 260 possible working days in a year (dis-
regarding their length), the biggest difference between any two percentages in the
same year, 0.61%, represents about 1-1/2 working days. Because of the partial use
of interpolated data, no useful interpretation of the year-to-year changes can be
made. It seems, however, that the man-hours not worked but paid in the Synthetic
Textile Mills industry have increased at a somewhat faster rate than those in Textile
Industries, the initial disparity having been more than made good by 1961. Scrutiny
of individual Census returns suggests that most of the impetus for this relatively
faster rate of growth came from the fibre producing establishments.

The tendency already noted for the length of the working week of wage-
earners to decline over the period from 1947 to 1961 was even more pronounced in the
case of salaried employees. By contrast with the situation for wage-earners, however,
the levels of the data for Synthetic Textiles and Silk, Textile Products, and Manu-
facturing were relatively close. In the first two cases, average hours paid per week
decreased from exactly the same level and by exactly the same amount between 1947 and

and 1960(20) i.e. from 41.2 to 38.6, or by 6.3% while in Manufacturing, there was a decrease from 40.4 to 38.5 hours, or of 4.7%.

For the longest period over which comparisons between the two classes of persons employed in Synthetic Textiles and Silk are possible, namely 1947 to 1960, wage-earners lost ground relative to salaried employees, with an overall decrease in average hours paid per week of 3.2% as against 6.3% for the latter group.

Remuneration of Labour - The remuneration of labour in the Synthetic Textile Mills industry may be considered from at least two points of view, as a cost to the industry and in terms of the earnings of its employees. As regards the former, the questions of interest are the relative importance of labour costs in the industry, the extent to which these may have varied over the period in question and how they compare with those of other industries and industry groupings. To the extent that salaries and wages paid can be taken as an approximation of total labour costs and value added in manufacturing as an approximation of total factor income, the ratio of these magnitudes is a useful indication of the importance of labour costs. By implication such ratios are, of course, also highly suggestive of the capital intensity of the industries concerned. The value of such ratios for 1961, together with their component data, are shown in Table Ii on the following page, for Synthetic Textile Mills, Textile Industries and Manufacturing, as well as for a number of other industries and industrial groupings chosen to illustrate the wide limits within which the ratio appears to fluctuate.

The ratio for the Synthetic Textile Mills industry is very close to that for Manufacturing and a little lower than that for the Textile Industries major group. Some indication of the annual fluctuations of the ratio of salaries and wages paid to value added in manufacturing operations in the industry between 1947

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(20) The Annual Survey of Earnings and Hours of Work in Manufacturing, on which these data are based, was not carried out in 1961.

and 1961 may be derived from Table 3 of Part III of this report. In fact, the ratio seems to have fluctuated within a very narrow range of its 1961 value except between 1953 to 1958 when it was appreciably higher. The explanation for this increase may be partially bound up in the decreased profitability of the industry during this period, which has been commented on in the study referred to earlier.(21)

TABLE 11. Salaries and Wages Paid as Per cent of Value Added
by Selected Manufacturing Industries, Industry Groups
and Manufacturing, as Originally Reported,
Canada, 1961

Industries	Salaries and wages paid	Value added by manufacture	Salaries and wages paid as per cent of value added by manufacture
	thousands of dollars		per cent
Textile industries	212,558	392,689	54.13
Synthetic textile mills ...	59,393	123,478	48.10
Food and beverage industries	687,996	1,704,715	40.36
Breweries	40,882	197,399	20.71
Petroleum and coal products industries	85,340	290,699	29.36
Transportation equipment industries	522,470	828,670	63.05
Aircraft and parts manufacturers	141,930	192,085	73.89
Manufacturing	5,231,447	10,682,138	48.97

Source: Dominion Bureau of Statistics, Manufacturing Industries of Canada, Section A, Summary for Canada, 1961, DBS Catalogue No. 31-203.

The average hourly earnings of wage-earners in the Synthetic Textiles and Silk industry rose from $0.63 in 1947 to $1.45 in 1961, or by 130%. These figures compare closely with those of the Textile Products major group, where there was an increase from $0.62 to $1.38 or of 123%. In manufacturing, the overall increase was about the same, 122% but from a somewhat higher initial level, with average hourly

(21) Tariff Board, op. cit., pages 75-81.

earnings in 1961 being $1.83. In the case of establishments producing filament
yarns and staple fibre only, where separate data were available after 1957, the
level of earnings in 1961 was, at $1.80 quite close to the Manufacturing average,
with that for Spun Yarns and Fabrics being correspondingly lower than the average
for the industry as a whole at $1.18.

Average hourly earnings of salaried employees in Synthetic Textiles and
Silk in 1947 were, at $1.12, about 8% below those in Textile Products ($1.22) and in
Manufacturing ($1.23). By 1960, however, they had increased by 112% to $2.39, which
almost exactly matched the increase of 112% in Manufacturing to $2.61. In Textile
Products, the overall increase to $2.31 was proportionately smaller (89%), so that
Synthetic Textiles and Silk improved its relative standing within the major group.
A comparison of the increases between 1947 and 1960 in the average hourly earnings
of wage-earners and salaried employees in Synthetic Textiles and Silk indicates that
the former, with an increase of 127%, gained relatively to the latter, where the in-
crease was smaller at 113%.

Capital and Repair Expenditures

It would be extremely useful from both the descriptive and analytical view-
points to have estimates of capital stock by three-digit industry within Manufacturing
so that comparisons similar to those made above for Synthetic Textile Mills and the
aggregates of which it forms a part could also be made in respect of this important
characteristic. Such data are not at present available(22), and the insights which
they might have revealed must be sought from data relating to new capital and repair
expenditures,(23) as shown in Table Ij on the following page.

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(22) A programme of data development in this area at the Dominion Bureau of Statistics
    is well advanced, and a reference paper presenting estimates for the manufacturing
    industries (2-digit, or major group, level), and reviewing the concepts, sources
    and methods, is scheduled for early publication.
(23) See Part IV, General Technical Notes, page 91.

TABLE Ij. New Capital and Repair Expenditures in Synthetic Textile Mills,
Textile Industries, and Manufacturing, Canada, 1947-61

-35.-

Year	Synthetic textile mills			Textile industries (except clothing)	Manu-facturing	Synthetic textile mills construction as per cent of synthetic textile mills total	Synthetic textile mills total as per cent of textile industries total	Synthetic textile mills total as per cent of manufacturing total
	Construc-tion	Machinery and equipment	Total					
	millions of dollars					per cent		
1947	6.1	15.5	21.6	51.6	801.2	28.2	41.9	2.7
1948	2.8	15.4	18.2	53.7	901.8	15.4	33.9	2.0
1949	2.2	14.9	17.1	50.6	874.6	12.9	33.8	2.0
1950	2.6	12.6	15.2	46.8	849.1	17.1	32.5	1.8
1951	5.0	19.0	24.0	59.8	1,215.1	20.8	40.1	2.0
1952	3.3	16.2	19.5	50.9	1,431.3	16.9	38.3	1.4
1953	5.2	14.3	19.5	47.3	1,448.9	26.7	41.2	1.3
1954	5.7	19.4	25.1	45.5	1,310.6	22.7	55.2	1.9
1955	3.5	15.0	18.5	47.5	1,459.7	18.9	38.9	1.3
1956	3.2	17.2	20.4	58.8	1,971.6	15.7	34.7	1.0
1957	3.3	21.5	24.8	60.5	2,092.8	13.3	41.0	1.2
1958	1.2	16.0	17.2	42.1	1,666.9	7.0	40.9	1.0
1959	1.5	12.7	14.2	42.7	1,806.3	9.9	33.3	0.8
1960	1.6	13.8	15.4	48.1	1,849.0	10.4	32.0	0.8
1961	1.7	13.2	14.9	51.6	1,766.7	11.4	28.9	0.8
Totals	48.9	236.7	285.6	757.5	21,445.6	...	...	...

Source: Data for Textile Industries and Manufacturing originate from - Private and Public Investment in
Canada, Annual, DBS Catalogue No. 61-504 - Private and Public Investment in Canada Outlook, Annual,
jointly prepared by the Dominion Bureau of Statistics and the Economic Branch of the Department of
Trade and Commerce. For the Synthetic Textile Mills industry, the figures were obtained from the
ledgers of the Business Finance Division of the Bureau, except those for 1947, which were taken from
"Synthetic Textiles and Silk Industry, 1955", DBS Catalogue No. 34-208.

Within the Synthetic Textile Mills industry, expenditures on construction comprised the more variable portion of the total, the data for 1947 and 1958 representing the extreme values of the series in both absolute and percentage terms. Such expenditures tend of course, to be more usually associated with the addition of new capacity rather than with the replacement of old, and the sharp decrease in their level which took place after 1957 coincides with the completion at about that time of the sustained period of major expansion of productive facilities which was described earlier.

Total capital and repair expenditures in the Synthetic Textile Mills industry constituted, on the average, about 38% of the Textile Industries total between 1947 and 1961. As may be seen from Table Ij, the year-to-year variations in this percentage were somewhat erratic, but the highest values seem to have been registered between 1951 and 1958, which reflects the generally high levels of the absolute data for Synthetic Textile Mills during those years and the greater stability of the Textile Industries total over the whole period. On the other hand, capital and repair expenditures in the Synthetic Textile Mills industry between 1947 and 1961 seem to have constituted a gradually diminishing share of the Manufacturing total.

PART II

TRENDS AND FLUCTUATIONS IN OUTPUT

PER UNIT OF LABOUR INPUT

PART II

TRENDS AND FLUCTUATIONS IN OUTPUT PER UNIT OF LABOUR INPUT

Summary of Findings

The predominant impression conveyed by the results presented below for all establishments in the Synthetic Textile Mills industry is one of continuous and rapid growth in the volume of output during the greater part of the period 1947-61, accompanied by a fairly stable or even declining volume of labour input, so that the various measures of output per unit of labour input show an even more impressive record of growth. The overall increase of the latter was considerably greater than was achieved in Manufacturing as a whole.

At the same time, the measures relating to Synthetic Textile Mills in total conceal quite different patterns of growth in output per unit of labour input and its components for those establishments engaged in fibre production and fibre processing respectively. In the former case, the growth of output was greater over-all and less variable from year to year, but achieved with a generally increasing volume of labour input. On the other hand, growth in the volume of output of the fibre processing establishments was both smaller and more variable than for the industry as a whole, but accompanied by a decline in the volume of labour input. Although these differences with regard to labour input in the two branches of the industry partially offset the differences on the output side, the growth of output per unit of labour input of the fibre producers was considerably greater than that of the fibre processors.

No comparisons with corresponding measures for the United States can be made at the present time. As previously noted,(1) the U.S. Bureau of Labor Statistics normally publishes indexes of output per unit of labour input for the Synthetic Fibres industry (roughly comparable to fibre producers, as here defined),

(1) See page 17 above.

but these have been temporarily withdrawn pending revision to the underlying output
data. No figures corresponding to those presented here for fibre processors are
available. It is hoped that the revised BLS figures for Synthetic Fibres will be
available in time for appraisal and comparison in the published version of this
report.

Growth of Real Output, 1947-61

As may be seen from Chart 1 of Part III, the growth patterns of real out-
put during the period 1947-61 were markedly different as between the Synthetic
Textile Mills industry and its two component branches. For the industry as a whole,
both gross and net measures increased by rather more than 200% over the entire period,
the average rates of growth calculated by the least squares of logarithms method
being 7.2 and 6.8 per cent per annum respectively. For the fibre producing
establishments, the increases of the two measures were again very similar but, at
almost exactly 400%, substantially greater than for the industry as a whole, the
annual growth rates being 11.5% for the gross and 11.4% for the net measure. In the
case of the fibre processing establishments, however, the increases in gross and
net output were not only much lower but, at 137% and 102% overall or, in terms of
their average annual rates, 3.8% and 2.6% respectively, also exhibited a marked
disparity.

For the industry as a whole, year-to-year changes in both net and gross
output were positive from 1947 to 1951 and from 1954 on. With the minor exception
of the net measure between 1953 and 1954, changes in both the net and gross output
of the fibre producing establishments were positive in all years. Thus the period
of irregular change in the output of the industry as a whole between 1951 and 1954
derives mostly from the sustained decrease in both measures of output experienced
by the fibre processing establishments. On the other hand, the decreases of output
in the latter branch of the industry between 1956 and 1957 were apparently more
than offset in the total industry measures by the coincident increases of the fibre
producers.

It may be noted that the growth of real domestic product in manufacturing during the same period suffered setbacks between 1953 and 1954, 1956 and 1958, and between 1959 and 1960.(2) It therefore seems that, while the growth of real output in the fibre producing establishments was apparently immune to the factors at work in the wider context, these may have had some effect on the growth of output in the fibre processing establishments, although the timing of the downturns is not identical in both cases.

As already noted, the differences between the gross and net measures of real output are not of major significance for the Synthetic Textile Mills industry as a whole, nor for the fibre producing establishments. The faster growth of net output in the latter between 1950 and 1952 can probably be identified with the change-over which took place at this time from imported to domestically produced nylon intermediaries. Again, the occasions such as 1953-54 and 1955-56, when the growth of net output lagged behind that of gross output, can at least partially be identified with the start-up of new establishments when the ratio of materials used to production would be temporarily higher than normal. Since the fibre processing establishments comprise a larger and more heterogeneous group than the fibre producing establishments and since the methods used in splitting the output data for the industry as a whole derive the fibre processing measures as residuals, it is difficult to account unambiguously for the divergence between the growth rates of the gross and net output of fibre processors which took place between 1955 and 1960. It is possible, however, that this may be accounted for by a shift in the composition of output towards products requiring relatively less processing.

Changes in Labour Input, 1947-61

Before proceeding to a direct description and analysis of the various measures of output per unit of labour input, a brief review of the main changes of

(2) Dominion Bureau of Statistics, Indexes of Output per Person Employed and per Man-hour in Canada, Commercial Nonagricultural Industries, 1947-63, Ottawa, Queen's Printer, 1965, DBS Catalogue No. 14-501, page 15.

labour input for the three groupings also seems desirable. For this purpose, attention is concentrated solely on changes in the number of persons employed since no separate man-hours data have been compiled for the fibre producing and fibre processing establishments.

Chart 2 of Part III shows that the trends of employment for the industry as a whole again represent an average of two widely differing patterns of change in its component branches. In the fibre producing establishments, the employment of production and related workers only and of persons employed increased between 1957 and 1961 at average annual rates of 2.3% and 3.5% respectively. In the fibre processing establishments, on the other hand, the trend of employment was downwards, with the production and related workers series decreasing at the rate of 3.5% per annum and that of persons employed at 2.2% per annum.

The most noteworthy of the year-to-year changes shown on Chart 2 appears to be the sharp reduction in the employment of production and related workers in fibre processing establishments which was sustained from 1951 through 1954 and coincided with the decrease in output noted on Chart 1.

Overall Changes in Output per Unit of Labour Input, 1947-61

Charts 3 and 4 of Part III, which show real net output per production and related worker and per person employed respectively for the Synthetic Textile Mills industry, its component branches and Manufacturing for the period 1947 to 1961, bring to the fore the most significant differences in productivity change between the various levels of aggregation. Generally speaking, differences between net and gross measures of output and between measures of employment and man-hours are not large, and the generalizations made here on the basis of the particular series depicted in Charts 3 and 4 are much the same as those which would have emerged from series based on alternative combinations of output and input data.

Overall increases in real net output per production worker between 1947 and 1961, shown in Chart 3, were 232.3%, 302.1%, 141.3% and 54.2% for all establishments,

fibre producers, fibre processors and manufacturing respectively. The corresponding growth rates, calculated in the same manner as previously described, were 8.8%, 8.8%, 6.2% and 3.3% per annum. While the linear trend appears in varying degrees to be a good fit to the data for all establishments, fibre processors and manufacturing, such is not the case for the data of the fibre producers, largely as a result of the period between 1952 and 1956. Similar orders of magnitude are reflected in the figures of real net output per person employed shown in Chart 4 where the overall increases for the fifteen-year period are 186.2%, 239.8%, 109.7% and 41.1%, again for all establishments, fibre producers, fibre processors and manufacturing respectively, the corresponding growth rates being 7.5%, 7.6%, 4.9% and 2.6%. Again, the qualification with respect to fibre producers appears to be necessary.

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

Charts 5 to 12 permit the analysis of year-to-year changes in a number of alternative measures of real net output per unit of labour input for the Synthetic Textile Mills industry and its two main branches based on the available measures of labour input. In general, as may be seen from Chart 2, year-to-year changes in persons employed and production and related workers are not significantly different in any of the three groupings under discussion. Again, at the level of the industry as a whole, the movements of the two man-hours indexes are very similar to those of the corresponding employment indexes, as may be seen from a comparison of Charts 11 and 12 with 5 and 8. Consequently, the main points of this section can be established on the basis of three charts only, 8, 9 and 10.

Chart 8, which shows real net output per person employed and its components for the Synthetic Textile Mills industry, brings out very clearly the relatively constant nature of year-to-year changes in the productivity measure at this level and the resultant good fit of the trend line. Between 1951 and 1954, decreases of the output measure were accompanied by relatively larger decreases of employment so that real net output per person employed still continued to increase.

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Quite a different picture emerges from Chart 9, which amply justifies the development of separate data for the fibre producing establishments. With the single exception of 1953-54, year-to-year changes in the real net output of the latter were positive. However, the growth of output per person employed was interrupted during the years 1952 to 1956. Examination of the employment series seems to suggest two distinct phases of relatively stable employment with a sharp increase taking place in the latter part of the 1952-56 period. Since it was in these years that several important establishments made their debut into the industry,(3) it may not be inappropriate to regard the middle nineteen-fifties as a transitional period during which the present structure of the fibre producing branch of the industry, importantly influenced by the true synthetics, began to emerge.

As shown in Chart 10, the fibre processing branch of the industry also experienced a period, from 1951 to 1954, during which the growth of real net output per person employed was interrupted. However, the period does not appear to have the same significance as that just discussed in Chart 9. It is not only shorter, but also by no means unique, output per person employed also having either decreased, or failed noticeably to increase, in 1947-48, 1949-50 and 1956-57. The general impression of year-to-year changes during the entire period from 1947 to 1961 remains one of reasonably close correspondence to the straight line logarithmic trend. Furthermore, the movements of output per person employed between 1951 and 1954 in the fibre processing branch of the Synthetic Textile Mills industry also differ from those between 1952 and 1956 in the fibre producing branch as far as the movements of their underlying components are concerned. In the former case, the period of unchanged productivity coincides with the sharp roughly matching decreases in output and input, while in the latter case output and input were generally increasing.

A direct comparison of the year-to-year changes in real net output per person employed in the Synthetic Textile Mills industry and its two component

(3) See Part 1, under "General Description and Characteristics of the Industry".

branches, shown in Chart 4 and expressed in Table IIa below in percentage terms,

brings to light certain apparent inconsistencies between the three sets of data.

TABLE IIa. Year-to-year Percentage Changes in Real Net Output
per Person Employed, Synthetic Textile Mills,
Canada, 1947-61

Year	Percentage change from preceding year		
	Fibre processors	Fibre producers	All establishments
	per cent		
1947	..	..	..
1948	- 2.8	+ 21.6	+ 3.9
1949	+ 17.6	+ 3.8	+ 13.3
1950	+ 0.2	+ 20.3	+ 8.3
1951	+ 17.7	+ 11.5	+ 15.8
1952	- 1.7	+ 23.4	+ 8.5
1953	+ 1.6	+ 2.7	+ 4.1
1954	- 4.3	- 1.5	+ 1.3
1955	+ 18.0	- 0.8	+ 11.2
1956	+ 4.1	- 6.8	+ 0.3
1957	- 5.5	+ 10.8	+ 5.1
1958	+ 8.6	+ 10.3	+ 8.0
1959	+ 9.0	+ 13.1	+ 15.5
1960	+ 3.4	+ 15.9	+ 9.0
1961	+ 14.4	+ 8.6	+ 6.4

Source: See Part III, Tables 1, 5, and 6, pages 53, 57, and 58.

It might at first sight be thought that any change in real net output per

person employed from one year to the next for the industry as a whole should in

some way fall between the changes originating in the component branches of the in-

dustry, i.e., if both the latter were positive, then the former would also be

positive with a numerical value between those of the latter, and so on. This would

imply, however, that the index of real net output per person employed for the in-

dustry as a whole is an average of the component indexes. Actually, the formula

used to measure output per person employed at the industry level is a simple ratio

of aggregates:

$$\frac{\sum q_1}{\sum q_o} \div \frac{\sum l_1}{\sum l_o} = \frac{\sum q_1 \sum l_o}{\sum q_o \sum l_1}$$

Where q and l are volume measures of output and input respectively at the component branch level, and the subscripts o and i indicate the base-year and given-year value of the terms. Alternatively, and perhaps more appropriately, it could be said that the component measures are derived from a disaggregation of $\frac{q_1 l_o}{q_o l_i}$, with the terms defined at the industry level.

Such being the case, the apparent inconsistencies of Table 11a can be accounted for in terms of the absolute levels of the output and input components of the three productivity measures. A numerical illustration, using the actual data for the change between 1953 and 1954 already referred to, will make this clearer.

TABLE IIb. Real Net Output per Person Employed, and Components, Synthetic Textile Mills, 1953 and 1954

	1953	1954	Percentage change
	thousands of dollars		
Real net output			
Fibre producers	49,106	47,560	- 3.1
Fibre processors	51,761	41,305	- 20.2
Total	100,867	88,865	- 11.9
Employment	number		
Fibre producers	3,743	3,679	- 1.7
Fibre processors	11,980	9,983	- 16.7
Total	15,723	13,662	- 13.1
Real net output per person employed	dollars		
Fibre producers	13,119	12,927	- 1.5
Fibre processors	4,321	4,138	- 4.2
Total	6,415	6,505	+ 1.4

Between 1953 and 1954, real net output decreased by a greater percentage than did employment in both the fibre producing and the fibre processing branches of the industry, thus resulting in a decrease of real net output per person employed in both cases. The sum of the two output figures, however, decreased by less than did the sum of the two employment figures so that, in consequence, real net output per person employed for the industry as a whole increased.

Output per Unit of Labour Input: Capital and Repair Expenditures, 1947-61

The relationship between output per unit of labour input, and capital and repair expenditures at the individual industry level may be an extremely complex one, but it seems worthwhile in this context to consider the analytical possibilities of a direct comparison between the movements of the two variables in the Synthetic Textile Mills industry. For this particular purpose, Chart IIa, which compares indexes of capital and repair expenditures with real net output per person employed between 1947 and 1961, suffers from the fact that the former are expressed in current dollars and are therefore not strictly consistent with the latter series. There are at the present time no published deflators by means of which these expenditures could be expressed in real terms, but this deficiency is not crucial, since it is probably sufficient to determine the direction rather than the precise magnitude of year-to-year changes.

There appears from the data of Chart IIa, to be no obvious relationship, either current or lagged, between the movements of the two series. As may be seen more clearly from Chart 8 of Part III, the trend underlying the increases of real net output per person employed is one of more or less steady growth, whereas the movements of the capital and repair expenditure series are generally irregular, although the level of the series between 1951 and 1957 was distinctly higher than in the initial and later years.

Chart IIa. Indexes of Real Net Output per Person Employed and New Capital and Repair Expenditures, Synthetic Textile Mills, Canada, 1947-61
(1949 = 100.0)

RATIO SCALE

Real Net Output
per Person Employed

New Capital and
Repair Expenditures
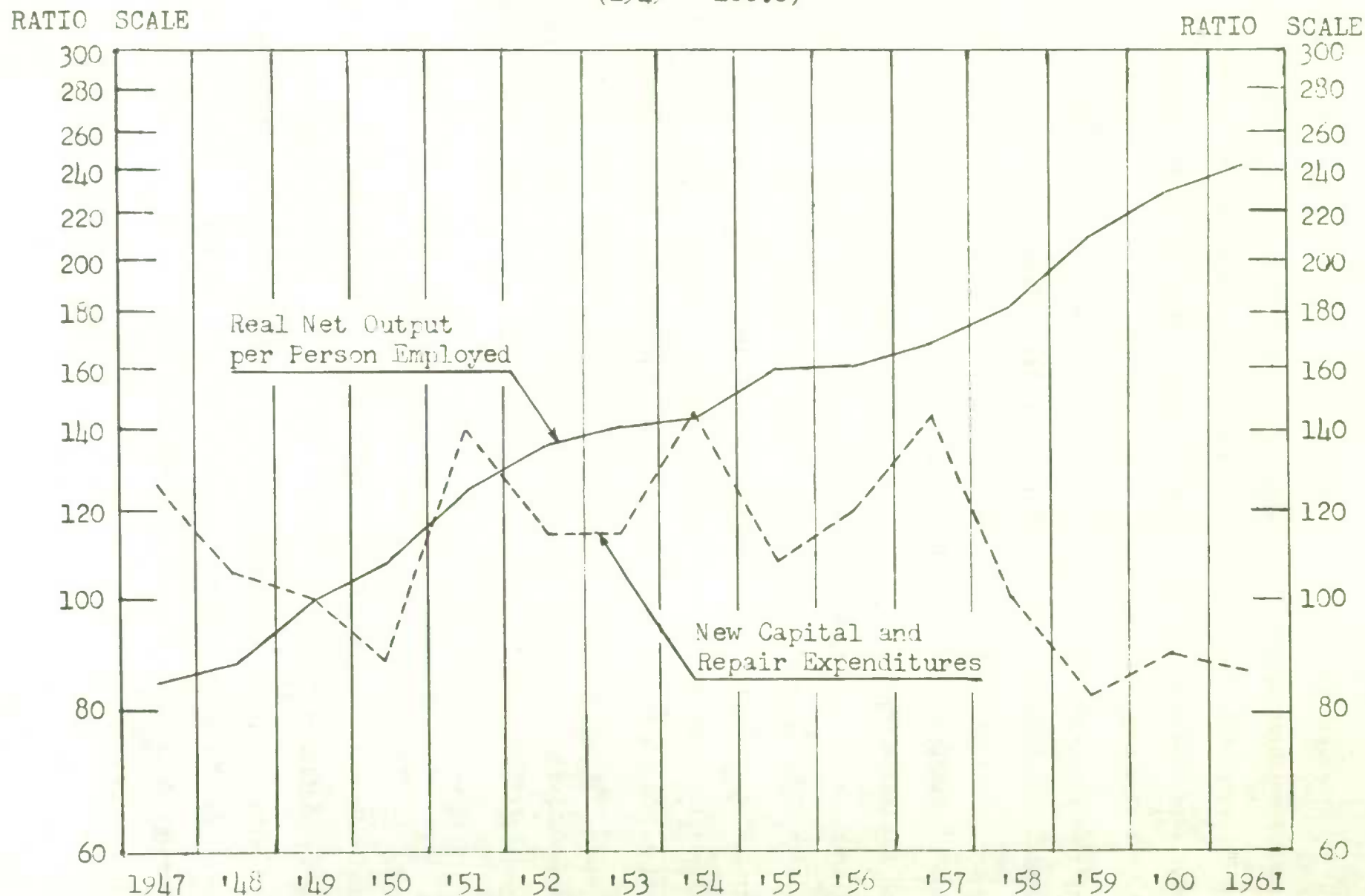
It may in fact be over-optimistic to expect any direct statistical evidence of the influence of new capital and repair expenditures on productivity in the Synthetic Textile Mills or any other industry. In the first place, its magnitude during any particular period will depend on the size of capital and repair expenditures relative to the pre-existing capital stock, and this may in any case be small by comparison with other factors currently at work, such as the level of capacity utilization, for example. This latter point is probably quite important for the Synthetic Textile Mills industry. Reference has already been made to the large additions to productive capacity during the early and mid-nineteen fifties, particularly in the fibre producing branch of the industry. If this additional productive capacity had been fully put to use as it became available, some immediate and noticeable effect on productivity might have resulted. In fact, it appears that it was brought into use only gradually, since important increases in output were achieved between 1957 and 1961 with no major additions to productive capacity.(4) Under the circumstances, the effects on productivity are bound to be so gradual and delayed as to elude any easy statistical identification.

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(4) The Tariff Board study previously quoted suggests (page 91) that at time of publication (1959) the industry was "over expanded".

PART III

STATISTICAL TABLES AND CHARTS

TABLE 1. Indexes of Real Output per Person Employed and per Man-hour, Synthetic Textile Mills, Canada, 1947-61

(1949=100.0)

Year	Real gross output per					Real net output per					Man-hours paid of production workers per unit of real gross output	Man-hours paid of persons employed per unit of real gross output
	Person employed	Production worker	Man-hour paid of persons employed	Man-hour paid of production workers	Man-hour worked of production workers	Person employed	Production worker	Man-hour paid of persons employed	Man-hour paid of production workers	Man-hour worked of production workers		
Old basis:												
1947	86.1	81.5	83.8	79.3	..	85.0	80.5	82.8	78.4	..	126.0	119.4
1948	91.5	87.9	90.6	86.2	..	88.3	84.8	87.4	83.2	..	116.0	110.4
1949	100.0	100.0	100.0	100.0	..	100.0	100.0	100.0	100.0	..	100.0	100.0
1950	109.1	112.9	111.2	113.7	..	108.3	112.1	110.4	112.9	..	88.0	89.9
1951	120.8	124.4	124.6	126.7	..	125.4	129.2	129.4	131.6	..	78.9	80.2
1952	128.8	138.3	133.8	141.4	..	136.0	146.0	141.3	149.2	..	70.7	74.7
1953	135.3	144.1	139.7	146.3	..	141.6	150.9	146.2	153.1	..	68.4	71.6
1954	142.0	160.6	146.9	161.9	..	143.5	162.3	148.4	163.6	..	61.8	68.1
1955	160.4	180.2	166.2	182.7	..	159.6	179.4	165.4	181.8	..	54.7	60.2
1956	162.3	183.3	172.8	190.4	190.4	160.1	180.9	170.5	187.9	187.9	52.5	57.9
1957	173.4	198.4	184.2	203.5	204.3	168.3	192.6	178.8	197.5	198.3	49.1	54.3
1958	188.9	214.7	206.2	231.2	232.2	181.7	206.5	198.3	222.4	223.4	43.2	48.5
1959	218.8	250.9	231.3	260.3	261.0	209.8	240.5	221.7	249.5	250.1	38.4	43.2
1960	239.4	267.3	254.8	282.1	283.6	228.7	255.4	243.5	269.6	271.0	35.4	39.2
1961	258.2	283.9	271.7	296.3	300.6	243.3	267.5	255.9	279.1	283.2	33.8	36.8
1961 as % of 1947 ...	300.0	348.3	324.2	373.6	379.1(1)	286.2	332.3	309.1	356.0	361.2(1)	26.8	30.8
Annual trend rate of change (%)	+ 7.9	+ 9.2	+ 8.6	+ 9.8	+ 9.9(2)	+ 7.5	+ 8.8	+ 8.1	+ 9.4	+ 9.4(2)	- 9.8	- 8.6
New basis:												
1959	218.8	250.9	231.3	260.3	261.0	209.8	240.5	221.7	249.5	250.1	38.4	43.2
1960	231.1	260.4	247.2	274.8	276.3	218.1	245.8	233.3	259.3	260.7	36.4	40.4
1961	246.1	273.5	261.4	286.8	290.6	224.9	249.9	238.9	262.1	265.6	34.9	38.3

(1) Based on 1947 man-hours paid.
(2) Calculated for the period 1947-61, using man-hours paid for 1947-56 inclusive.

TABLE 2. Indexes of Real Output and Labour Input, Synthetic Textile Mills, Canada, 1947-61

(1949=100.0)

Year	Real output		Persons employed		Production workers		
	Gross	Net	Number	Man-hours paid	Number	Man-hours paid	Man-hours worked
Old basis:							
1947	75.3	74.4	87.5	89.9	92.4	94.9	..
1948	87.6	84.5	95.7	96.7	99.7	101.6	..
1949	100.0	100.0	100.0	100.0	100.0	100.0	..
1950	116.4	115.6	106.7	104.7	103.1	102.4	..
1951	129.1	134.1	106.9	103.6	103.8	101.9	..
1952	120.3	127.0	93.4	89.9	87.0	85.1	..
1953	126.4	132.3	93.4	90.5	87.7	86.4	..
1954	115.3	116.5	81.2	78.5	71.8	71.2	..
1955	146.9	146.2	91.6	88.4	81.5	80.4	..
1956	151.4	149.4	93.3	87.6	82.6	79.5	79.5
1957	157.1	152.5	90.6	85.3	79.2	77.2	76.9
1958	162.1	155.9	85.8	78.6	75.5	70.1	69.8
1959	195.2	187.1	89.2	84.4	77.8	75.0	74.8
1960	213.3	203.8	89.1	83.7	79.8	75.6	75.2
1961	245.3	231.1	95.0	90.3	86.4	82.8	81.6
1961 as % of 1947	325.8	310.6	108.6	100.4	93.5	87.2	86.0(1)
Annual trend rate of change (%) ..	+ 7.2	+ 6.8	- 0.7	- 1.3	- 1.9	- 2.4	- 2.5(2)
New basis:							
1959	195.2	187.1	89.2	84.4	77.8	75.0	74.8
1960	209.4	197.6	90.6	84.7	80.4	76.2	75.8
1961	236.0	215.7	95.9	90.3	86.3	82.3	81.2

(1) Based on 1947 man-hours paid.
(2) Calculated for the period 1947-61, using man-hours paid for 1947-56 inclusive.

TABLE 3. Selected Statistics of Manufacturing Activities, Synthetic Textile Mills, Canada, 1947-61

Item		Old basis							
		1947	1948	1949	1950	1951	1952	1953	1954
Establishments	No.	40	45	48	47	46	48	47	46
Value of shipments(1)	$'000	84,870	107,142	124,125	147,048	166,550	157,629	146,418	132,403
Cost at factory of materials used	"	32,660	41,178	45,218	55,519	66,041	63,780	63,938	57,081
Cost at factory of fuel and electricity used ..	"	2,401	3,013	3,329	3,766	4,032	3,844	3,895	3,538
Value added by manufacture(2)	"	49,809	62,951	75,578	87,763	96,477	90,005	78,585	69,985
Value added per person employed(2)	$	3,382	3,911	4,491	4,888	5,361	5,724	4,998	5,123
Earnings, persons employed, as per cent of value added	%	48.8	48.8	47.8	45.7	46.3	47.5	55.9	58.1
Book value of manufacturing inventories, year end	$'000	..	..	..	..	..	..	..	33,845

		Old basis					New basis		
		1955	1956	1957	1958	1959	1959	1960	1961
Establishments	No.	48	47	44	48	48	46	50	56
Value of shipments(1)	$'000	159,234	161,161	163,810	177,214	207,061	203,210	216,530	248,718
Cost at factory of materials used	"	69,896	76,493	79,136	81,967	96,429	96,853	100,286	118,306
Cost at factory of fuel and electricity used ..	"	4,428	4,875	5,081	4,912	5,108	5,049	4,874	5,047
Value added by manufacture(2)	"	86,031	79,629	85,274	87,012	107,446	104,112	112,960	123,478
Value added per person employed(2)	$	5,584	5,074	5,591	6,027	7,161	7,086	7,566	7,791
Earnings, persons employed, as per cent of value added	%	54.5	61.7	59.8	56.7	49.9	49.6	48.7	48.1
Book value of manufacturing inventories, year end	$'000	35,847	38,293	44,033	39,873	42,869	42,869(3)	46,233(3)	46,379

(1) Figures up to and including 1952 represent value of production.
(2) Because of insufficient inventory data in 1953, this figure has been calculated from value of factory shipments and, therefore, only approximates true "Value added by manufacture".
(3) Figures do not completely reflect changes due to the 1960 Standard Industrial Classification and the New Establishment Concept.

TABLE 4. Selected Labour Statistics of Manufacturing Activities, Synthetic Textile Mills, Canada, 1947-61

Item		Old basis							
		1947	1948	1949	1950	1951	1952	1953	1954
Persons employed(1)	No.	14,728	16,097	16,828	17,955	17,997	15,723	15,723	13,662
Persons employed per establishment	"	368	358	351	382	391	328	335	297
Earnings	$'000	24,284	30,739	36,122	40,112	44,694	42,709	43,939	40,628
Man-hours paid(2)	'000	35,385	38,081	39,369	41,208	40,782	35,403	35,615	30,899
Production and related workers(3)	No.	13,101	14,134	14,178	14,622	14,719	12,335	12,437	10,184
As per cent of persons employed	%	89.0	87.8	84.2	81.4	81.8	78.5	79.1	74.5
Earnings	$'000	19,565	24,931	27,818	29,488	33,001	29,809	31,116	26,791
Man-hours paid - Estimated	'000	31,056	33,241	32,727	33,510	33,334	27,859	28,288	23,296
Reported	"	..	..	..	..	..	..	..	..
Man-hours worked	"	..	..	..	..	..	..	..	..
Man-hours not worked but paid as per cent of man-hours paid	%	..	..	..	..	..	..	..	..
Average hourly earnings(4)	$	0.63	0.75	0.85	0.88	0.99	1.07	1.10	1.15
Annual averages of average man-hours paid per week(4)	No.	44.5	44.5	44.0	45.2	43.9	44.2	44.2	43.9
Administrative and office employees(3)	"	1,627	1,963	2,650	3,333	3,278	3,388	3,286	3,478
Average hourly earnings(5)	$	1.12	1.23	1.25	1.43	1.62	1.74	1.75	1.85
Annual averages of average hours paid per week(5)	No.	41.2	41.3	41.2	40.6	39.9	39.9	40.3	39.8

Item		Old basis					New basis		
		1955	1956	1957	1958	1959	1959	1960	1961
Persons employed(1)	No.	15,408	15,694	15,251	14,436	15,004	14,693	14,930	15,801
Persons employed per establishment	"	321	334	347	301	313	319	299	282
Earnings	$'000	46,927	49,116	51,034	49,357	53,642	52,382	54,966	59,393
Man-hours paid(2)	'000	34,800	34,491						
			34,699	33,793	31,129	33,442	32,855	32,990	35,150
Production and related workers(3)	No.	11,562	11,718	11,225	10,710	11,037	10,932	11,302	12,132
As per cent of persons employed	%	75.0	74.7	73.6	74.2	73.6	74.4	75.7	76.8
Earnings	$'000	31,037	32,005	33,292	31,195	33,843	33,345	35,855	39,675
Man-hours paid - Estimated	'000	26,302	26,020	...	...	...	...	...	...
Reported	"	..	26,228	25,463	23,128	24,758	24,505	24,892	26,900
Man-hours worked	"	..	25,047	24,235	21,986	23,569	23,316	23,636	25,317
Man-hours not worked but paid as per cent of man-hours paid	%	..	4.5	4.8	4.9	4.8	4.9	5.0	5.9
Average hourly earnings(4)	$	1.18	1.22	1.31	1.35	1.37	1.36	1.44	1.47
Annual averages of average man-hours paid per week(4)	No.	44.5	43.0	43.6	41.5	43.1	43.1	42.4	42.6
Administrative and office employees(3)	"	3,846	3,976	4,026	3,726	3,967	3,761	3,628	3,669
Average hourly earnings(5)	$	1.90	2.06	2.15	2.32	2.28	2.28	2.36	2.39
Annual averages of average hours paid per week(5)	No.	39.9	39.6	39.4	38.9	39.1	39.1	38.6	38.5

(1) In 1961, the reported figures of administrative and office employees have been assigned in total to manufacturing activities although according to the New Establishment Concept, they are actually applicable to total activities. In this particular industry, however, nonmanufacturing activities are relatively unimportant and the comparability of 1961 data with those of previous years is therefore not significantly affected. (2) The administrative and office employees portion was estimated for all years by payroll deflation, while the figures relating to production and related workers were estimated by payroll deflation for 1947 to 1956 inclusive and linked to reported man-hours from 1956 on. See Part IV, General Technical Notes, pages 89 and 87. (3) The terms "production and related worker" and "administrative and office employee" as defined in the Census of Manufactures can be considered roughly synonymous with "wage-earner" and "salaried employee" respectively as used in the Employment Surveys. See Part IV, General Technical Notes, page 86, footnote 6. (4) From 1947 to 1955 inclusive, the figures originate from the publication "Review of Man-hours and Hourly Earnings, DBS Catalogue No. 72-202"; from 1956 on, they are calculated from reported data in the Census of Manufactures. (5) Data under the old basis were obtained from the publication "Earnings and Hours of Work in Manufacturing, DBS Catalogue No. 72-204"; and were estimated under the new basis by adjustment of old basis data.

TABLE 5. Indexes of Real Output, Input, and Real Output per Labour Input,
Synthetic Textile Mills, Canada, Old Basis, 1947-61
Fibre Producers

(1949=100.0)

Year	Real output		Employment		Real gross output per		Real net output per	
	Gross	Net	Persons employed	Production workers	Person employed	Production worker	Person employed	Production worker
1947	72.5	71.8	90.7	96.1	79.9	75.4	79.2	74.7
1948	86.8	89.0	92.4	93.5	93.9	92.8	96.3	95.2
1949	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1950	133.2	132.8	110.4	104.6	120.7	127.3	120.3	127.0
1951	148.8	151.8	113.2	106.2	131.4	140.1	134.1	142.9
1952	150.9	162.7	98.3	88.6	153.5	170.3	165.5	183.6
1953	165.7	178.0	104.7	94.7	158.3	175.0	170.0	188.0
1954	169.6	172.4	102.9	91.4	164.8	185.6	167.5	188.6
1955	207.2	212.3	127.8	112.6	162.1	184.0	166.1	188.5
1956	223.3	215.9	139.5	121.9	160.1	183.2	154.8	177.1
1957	249.6	244.1	142.3	127.1	175.4	196.4	171.5	192.1
1958	251.6	246.0	130.1	114.1	193.4	220.5	189.1	215.6
1959	311.8	317.7	148.5	128.7	210.0	242.3	213.9	246.9
1960	352.5	352.2	142.1	125.4	248.1	281.1	247.9	280.9
1961	363.1	368.9	137.1	122.8	264.8	295.7	269.1	300.4
1961 as % of 1947	500.8	513.8	151.2	127.8	331.4	392.2	339.8	402.1
Annual trend rate of change (%)	+ 11.5	+ 11.4	+ 3.5	+ 2.3	+ 7.7	+ 9.0	+ 7.6	+ 8.8

TABLE 6. Indexes of Real Output, Input, and Real Output per Labour Input,
Synthetic Textile Mills, Canada, Old Basis, 1947-61
Fibre Processors

(1949=100.0)

Year	Real output		Employment		Real gross output per		Real net output per	
	Gross	Net	Persons employed	Production workers	Person employed	Production worker	Person employed	Production worker
1947	74.0	75.8	86.7	91.4	85.4	81.0	87.4	82.9
1948	86.8	82.0	96.5	101.4	89.9	85.6	85.0	80.9
1949	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1950	109.6	105.9	105.7	102.7	103.7	106.7	100.2	103.1
1951	120.6	124.2	105.3	103.2	114.5	116.9	117.9	120.3
1952	105.7	106.7	92.1	86.6	114.8	122.1	115.9	123.2
1953	106.2	106.4	90.4	85.9	117.5	123.6	117.7	123.9
1954	87.2	84.9	75.3	66.6	115.8	130.9	112.7	127.5
1955	111.6	108.8	81.8	73.2	136.4	152.5	133.0	148.6
1956	111.9	111.9	80.8	72.1	138.5	155.2	138.5	155.2
1957	108.9	100.4	76.7	66.3	142.0	164.3	130.9	151.4
1958	113.2	104.9	73.8	65.2	153.4	173.6	142.1	160.9
1959	133.1	113.4	73.2	64.2	181.8	207.3	154.9	176.6
1960	139.7	119.8	74.8	67.6	186.8	206.7	160.2	177.2
1961	175.5	153.2	83.6	76.6	209.9	229.1	183.3	200.0
1961 as % of 1947	237.2	202.1	96.4	83.8	245.8	282.8	209.7	241.3
Annual trend rate of change (%)	+ 3.8	+ 2.6	- 2.2	- 3.5	+ 6.0	+ 7.4	+ 4.9	+ 6.2

- 58 -

CHART 1.   Indexes of Real Gross and Net Output,
Synthetic Textile Mills: All Establishments,
Fibre Producers, Fibre Processors, Old Basis, Canada, 1947-61
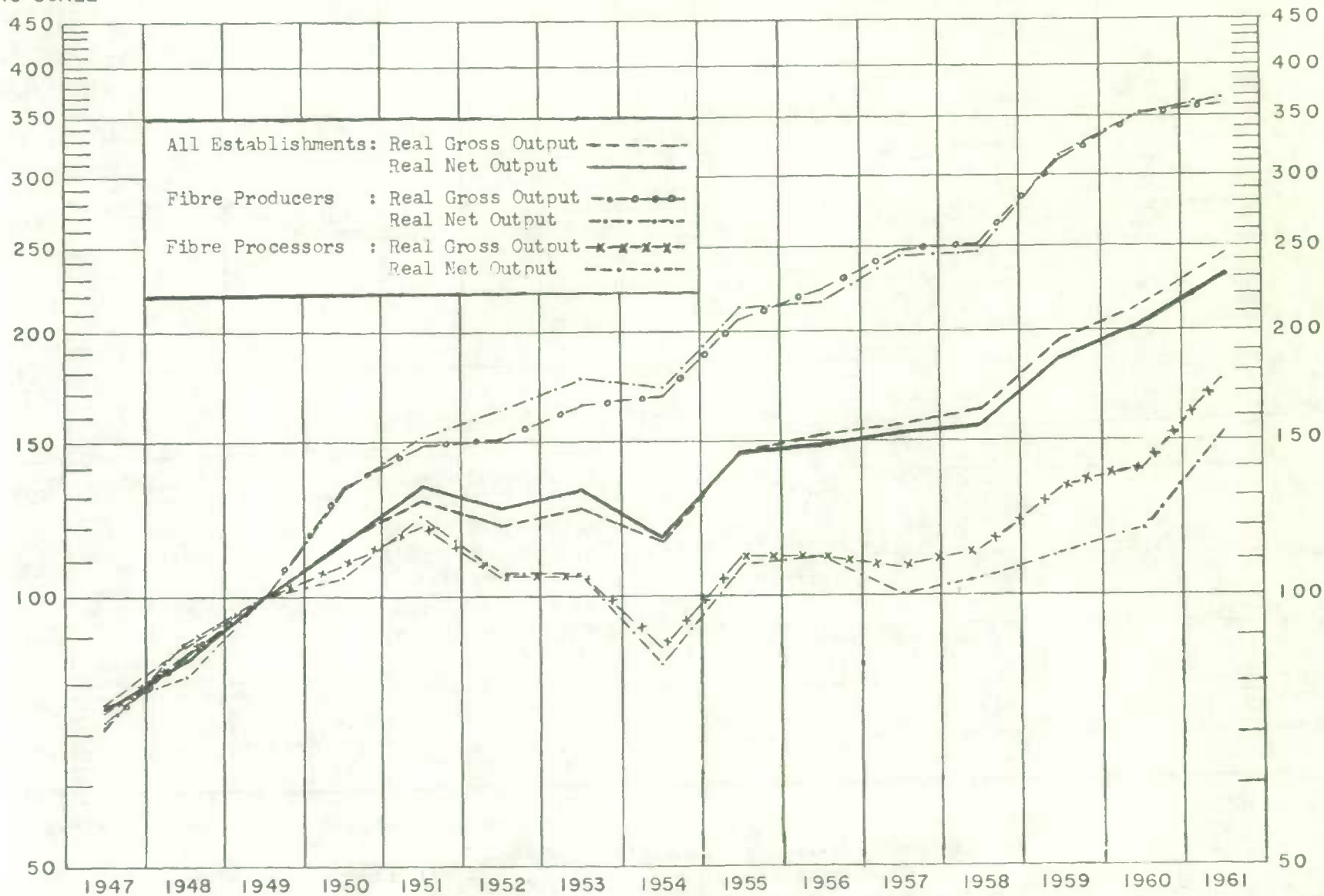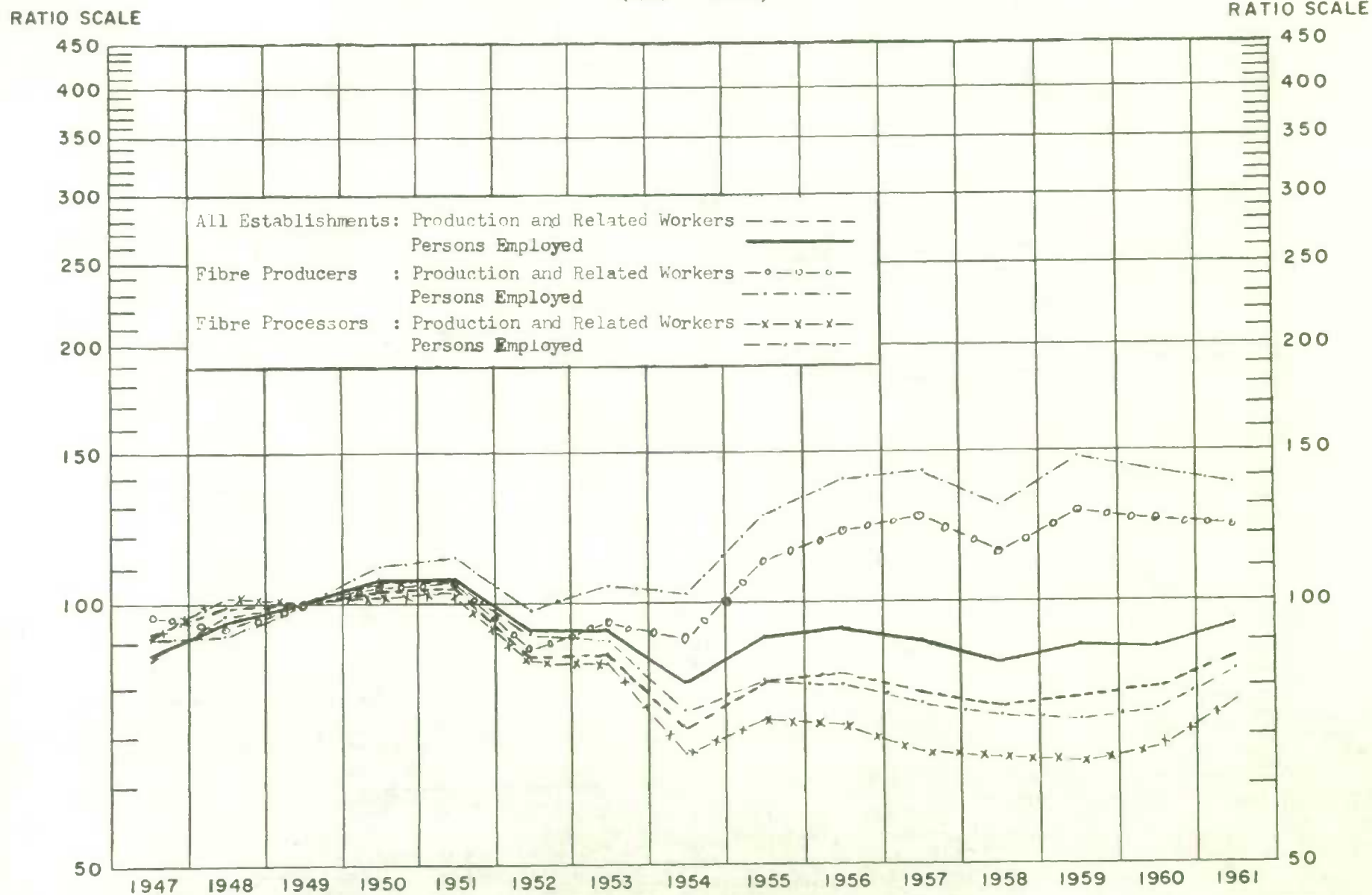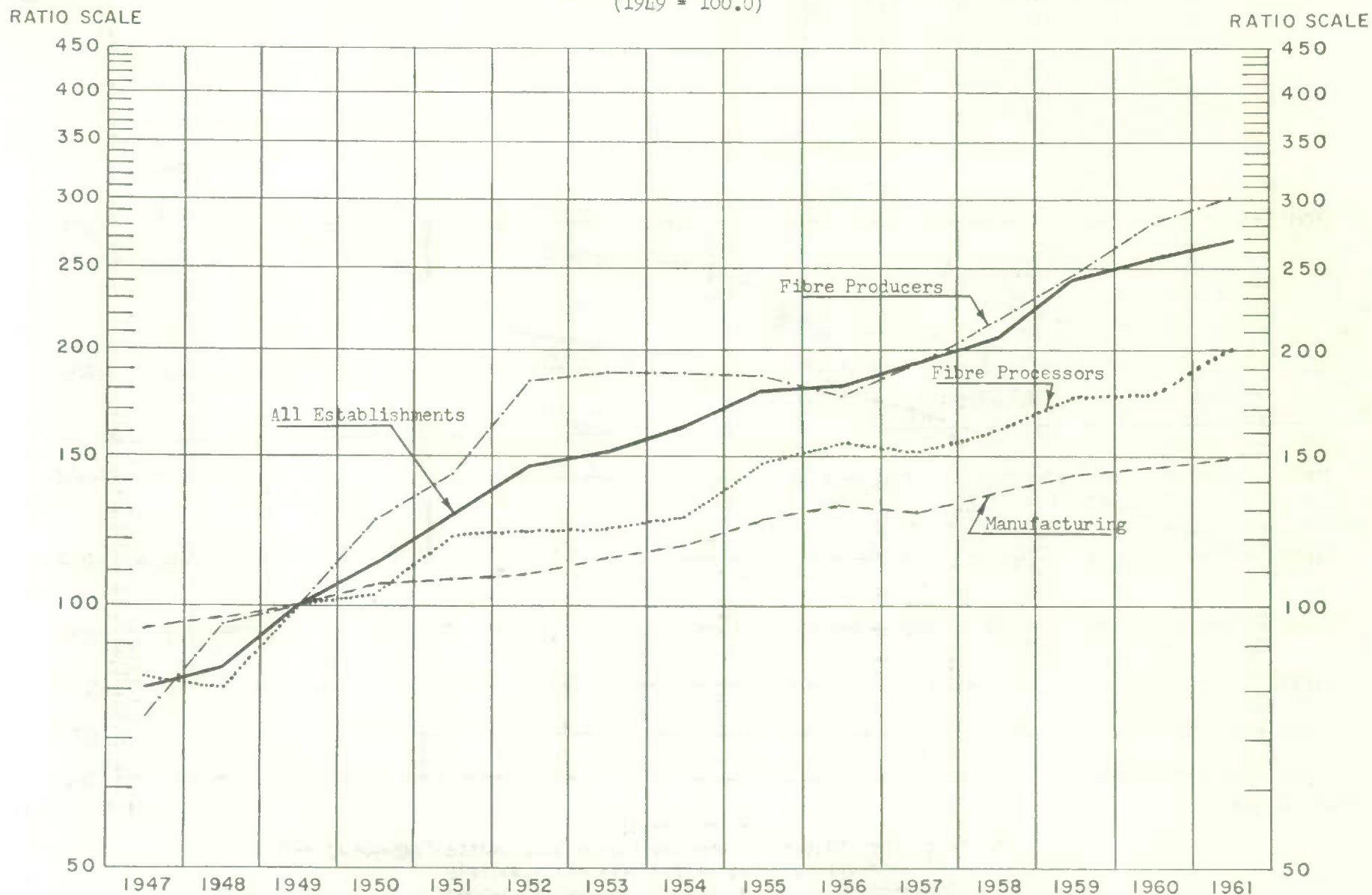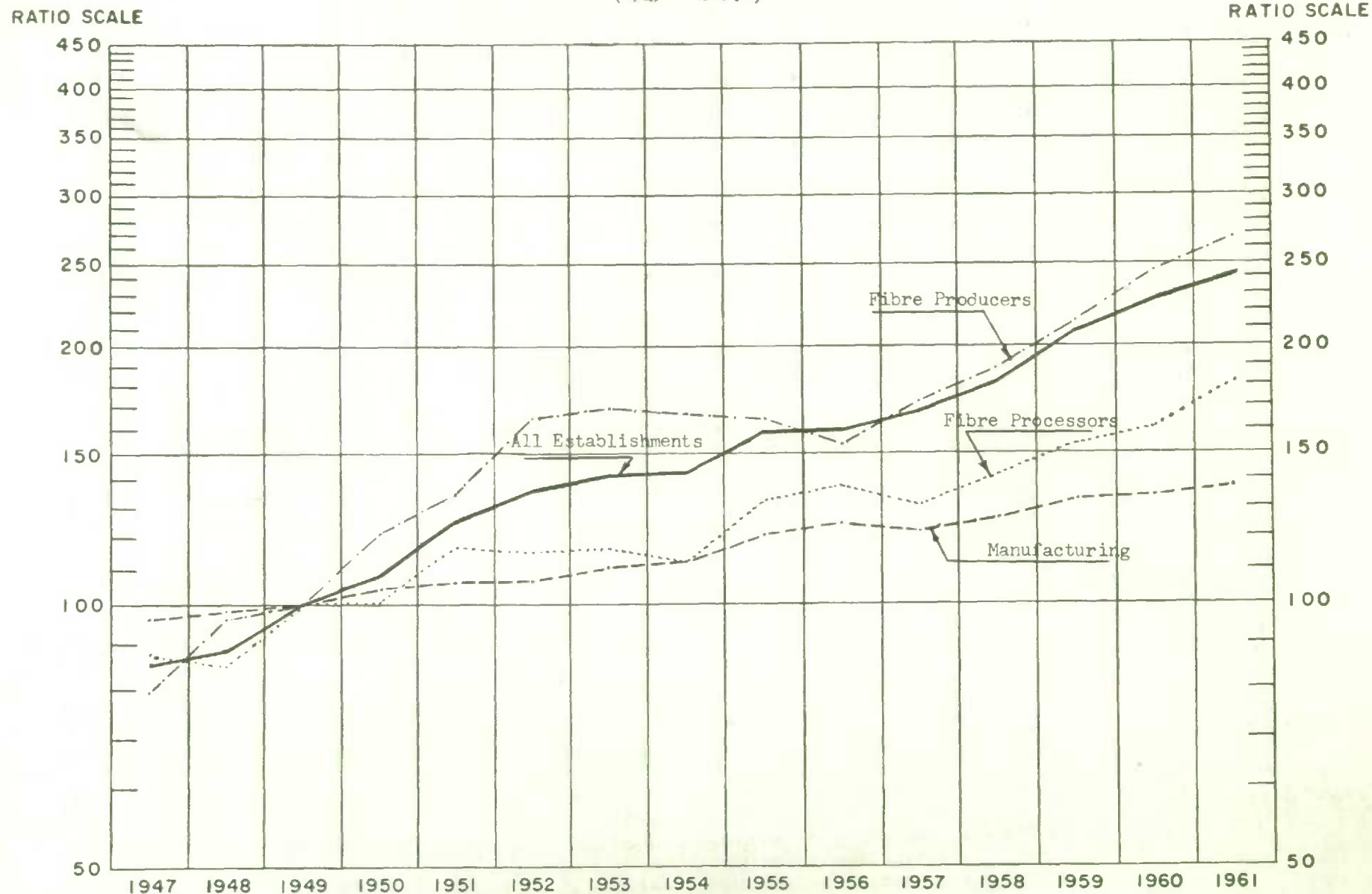(1949 = 100.0)

RATIO SCALE

All Establishments: Real Gross Output — — — — —
                    Real Net Output ————————
Fibre Producers   : Real Gross Output —•—o—•o—
                    Real Net Output —••—•• ——•—
Fibre Processors : Real Gross Output —x—x—x—x—
                    Real Net Output — —•—— —•• ——

CHART 2.   Indexes of Production and Related Workers and Persons Employed,
Synthetic Textile Mills: All Establishments,
Fibre Producers, Fibre Processors, Old Basis, Canada, 1947-61
(1949 = 100.0)

CHART 3. Indexes of Real Net Output per Production and Related Worker, Synthetic Textile Mills: All Establishments, Fibre Producers, Fibre Processors, and Manufacturing, Old Basis, Canada, 1947-61 (1949 = 100.0)

CHART 4.   Indexes of Real Net Output per Person Employed,
                     Synthetic Textile Mills: All Establishments,
       Fibre Producers, Fibre Processors, and Manufacturing, Old Basis, Canada, 1947-61
                              (1949 = 100.0)

CHART 5.   Indexes of Real Net Output per Production and Related Worker,
Synthetic Textile Mills, Old Basis, Canada, 1947-61
(1949 = 100.0)
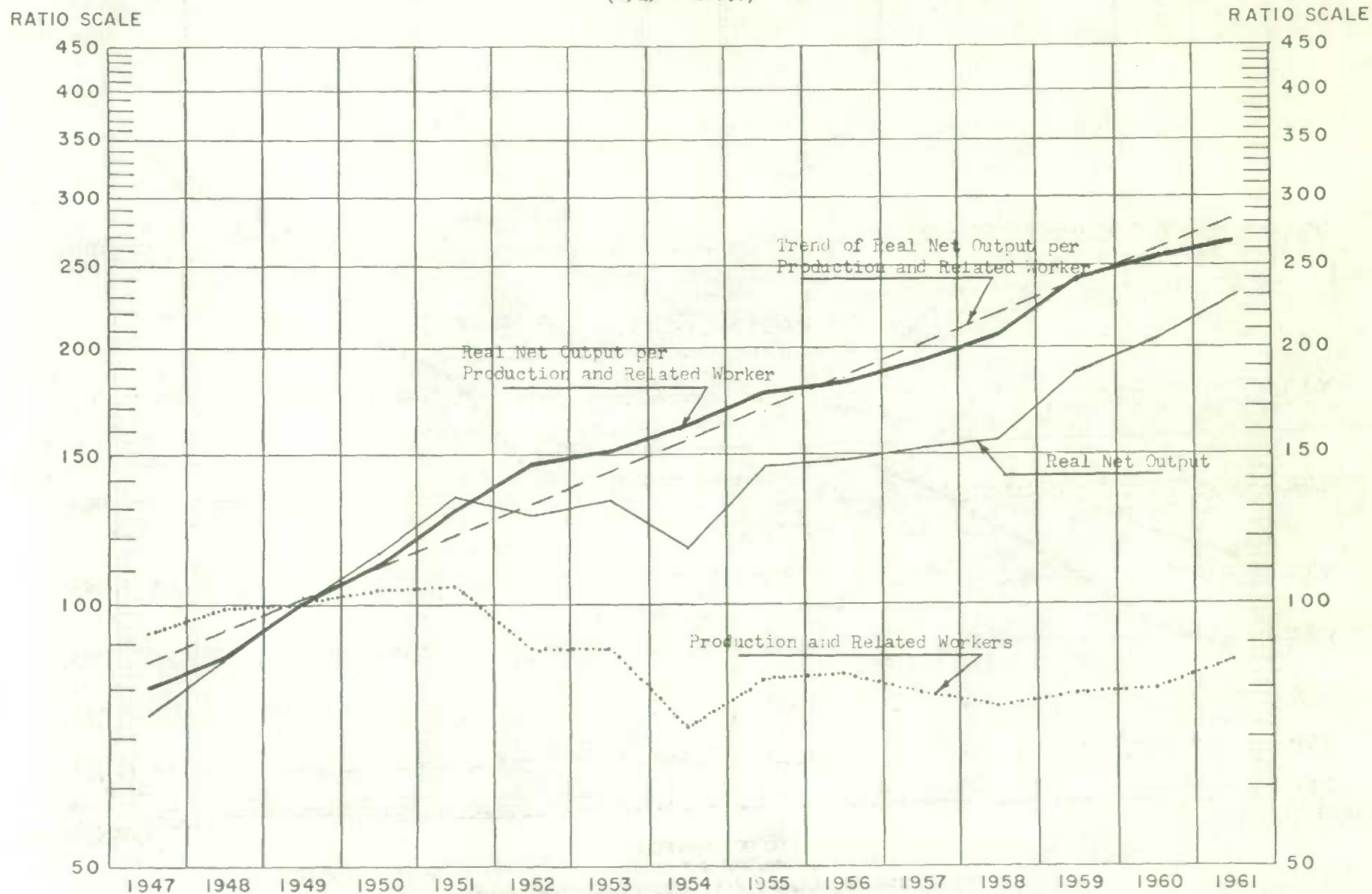
CHART 6. Indexes of Real Net Output per Production and Related Worker, Synthetic Textile Mills, Old Basis, Canada, 1947-61
Fibre Producers
(1949 = 100.0)
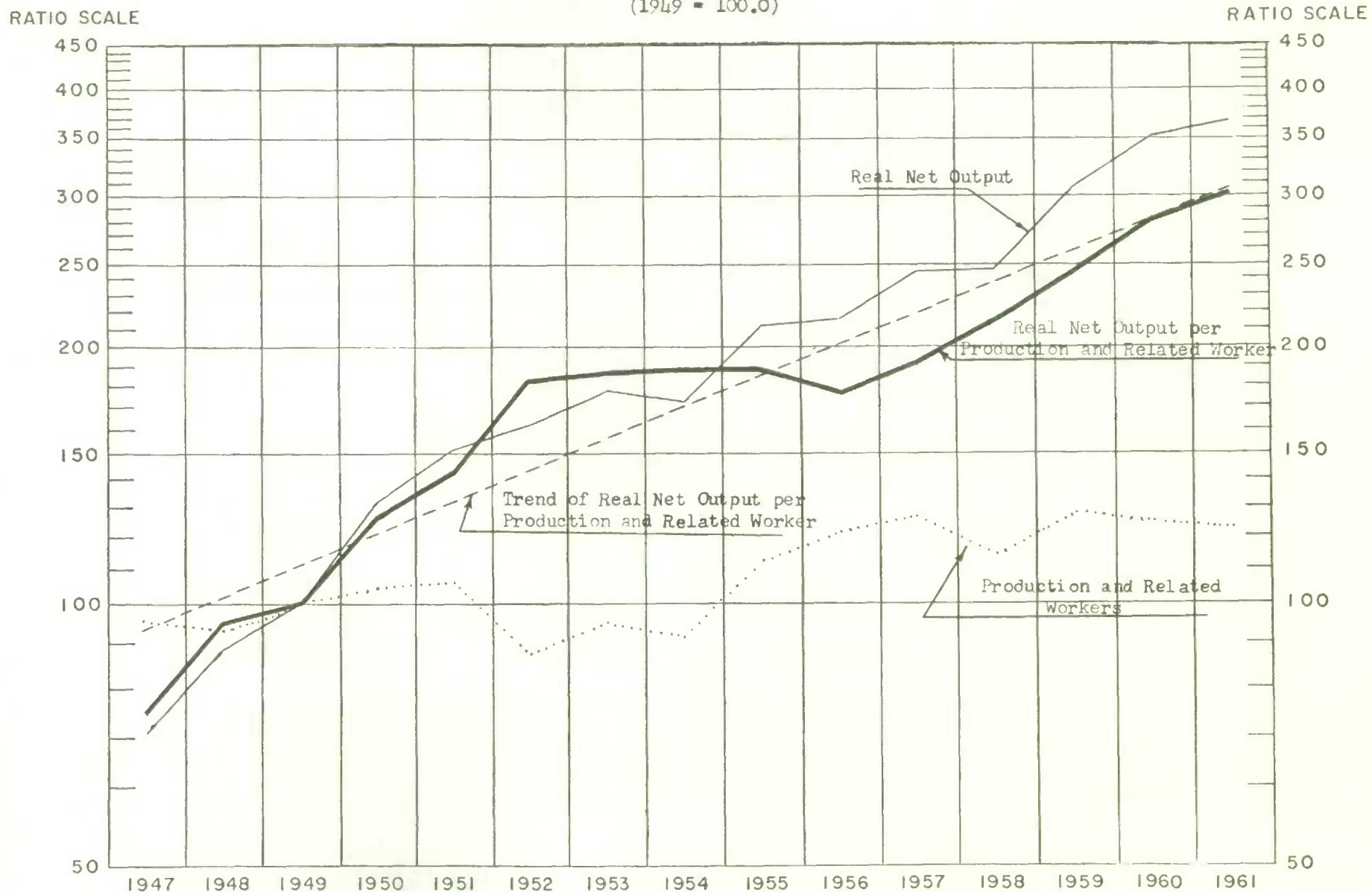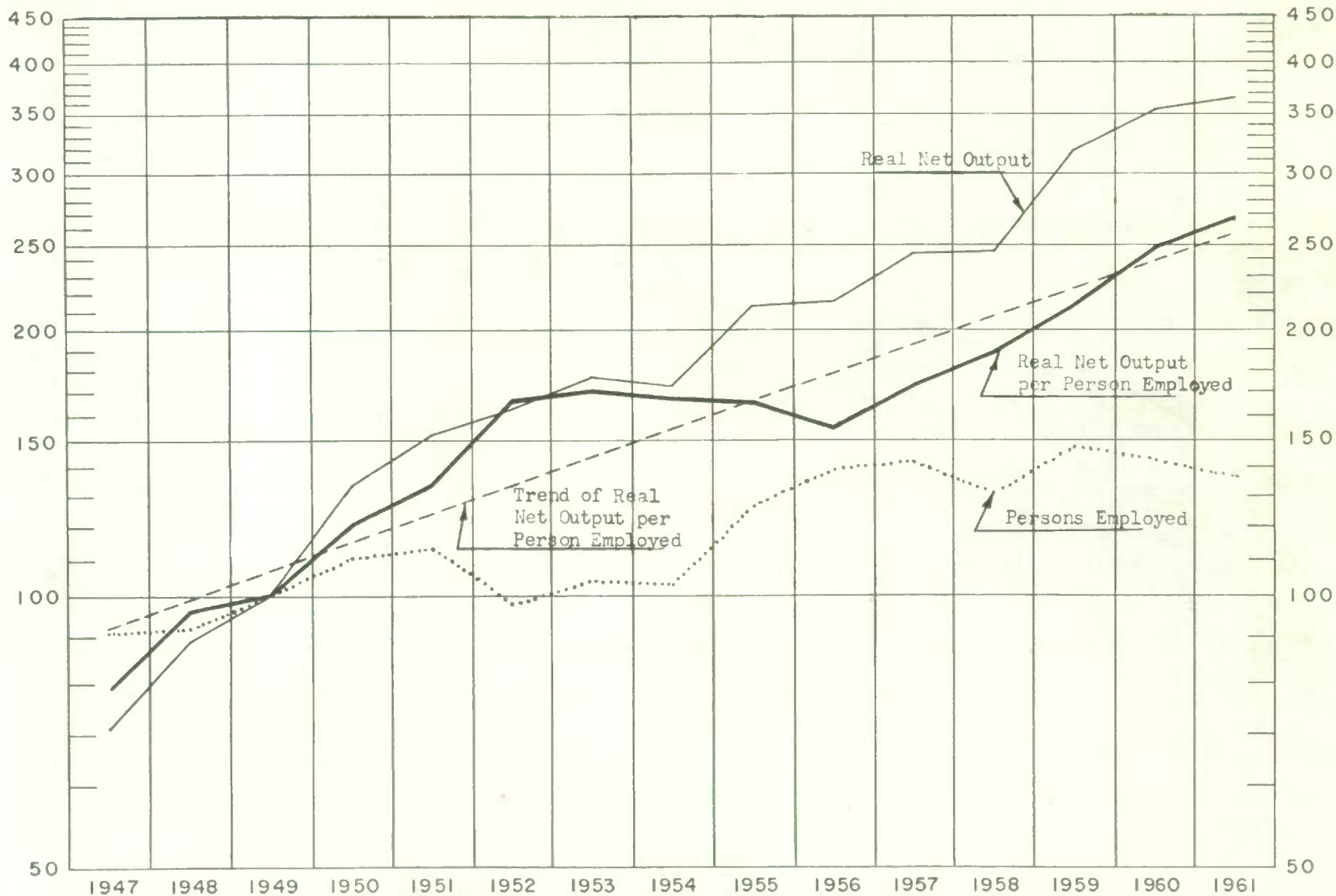
CHART 7.   Indexes of Real Net Output per Production and Related Worker,
                Synthetic Textile Mills, Old Basis, Canada, 1947-61
                            Fibre Processors
                            (1949 = 100.0)

Trend of Real Net Output per
Production and Related Worker

Real Net Output per
Production and Related Worker

Real Net Output

Production and Related
Workers
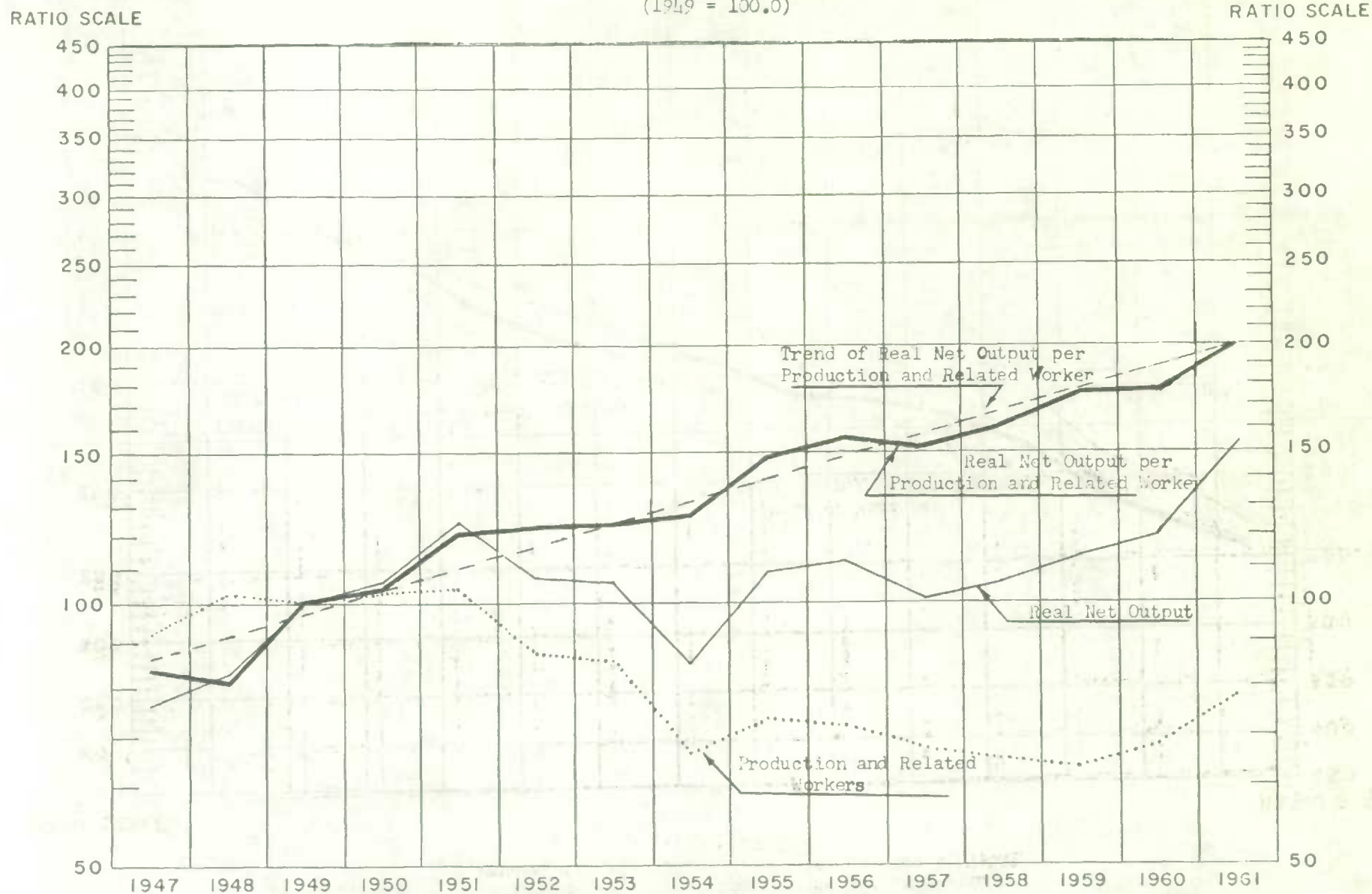
CHART 8.   Indexes of Real Net Output per Person Employed,
Synthetic Textile Mills, Old Basis, Canada, 1947-61
(1949 = 100.0)

CHART 9.   Indexes of Real Net Output per Person Employed,
                Synthetic Textile Mills, Old Basis, Canada, 1947-61
                            Fibre Producers
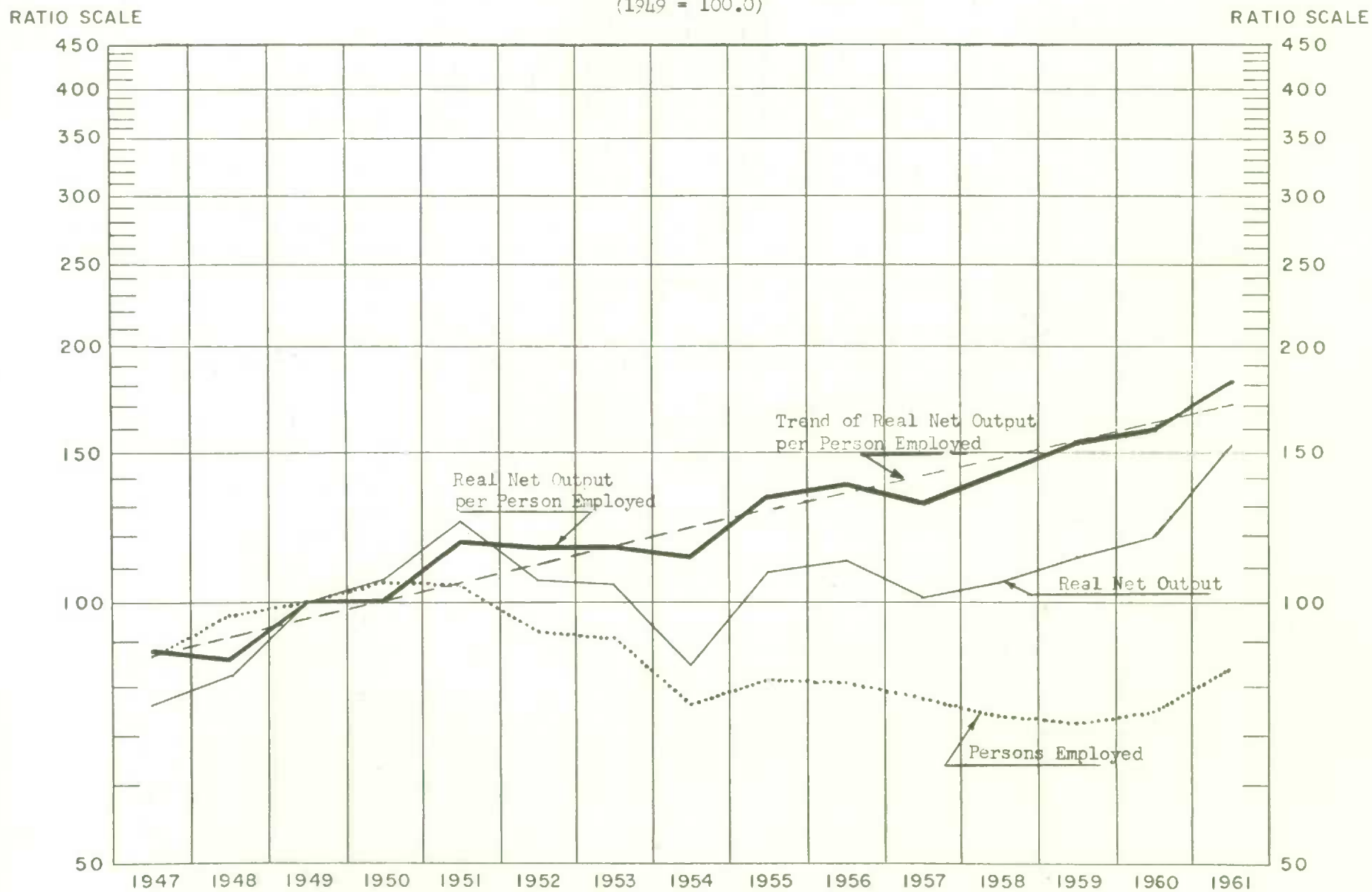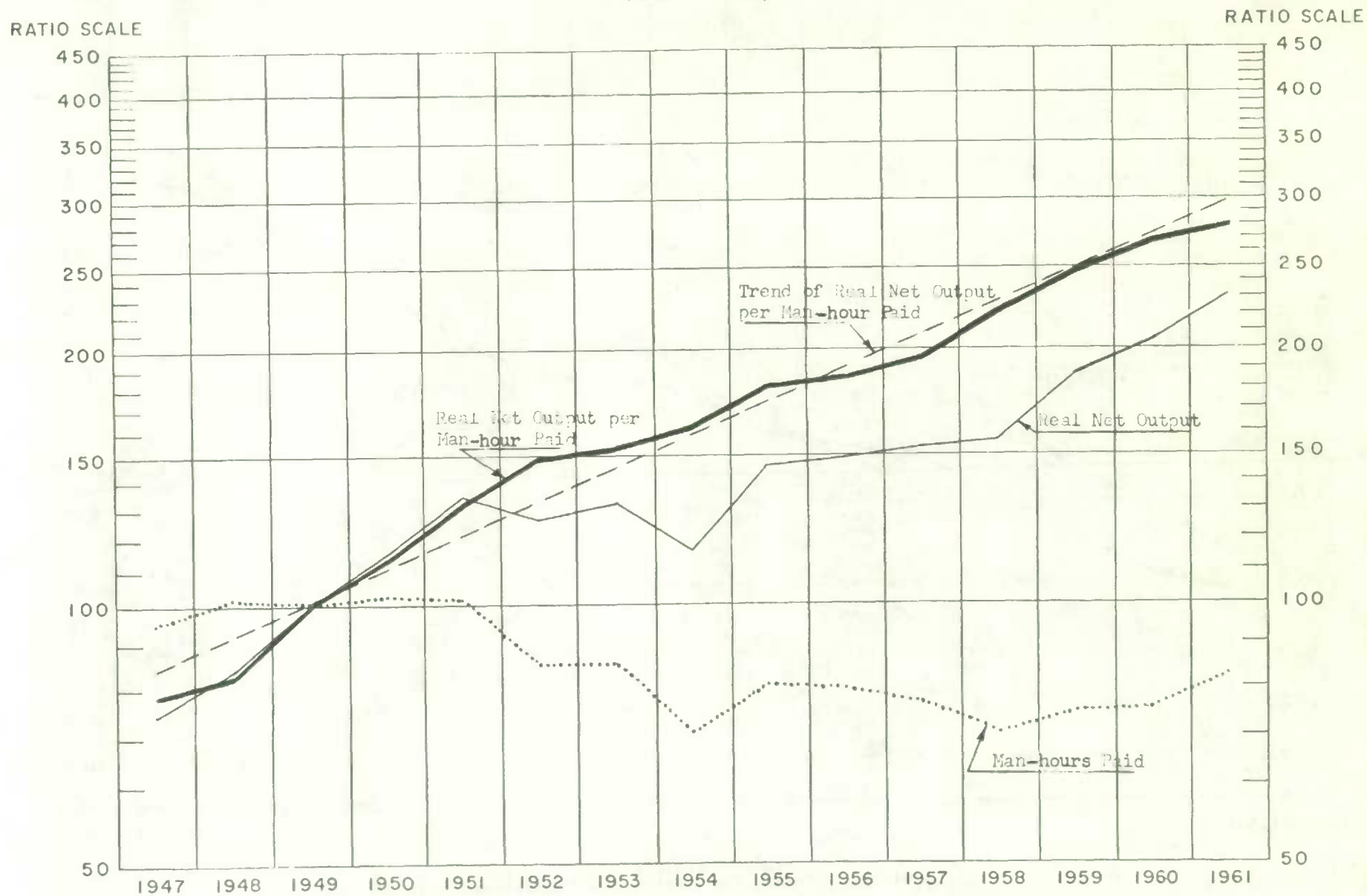   (1949 = 100.0)

RATIO SCALE   RATIO SCALE

CHART 10. Indexes of Real Net Output per Person Employed,
Synthetic Textile Mills, Old Basis, Canada, 1947-61
Fibre Processors
(1949 = 100.0)

CHART 11.   Indexes of Real Net Output per Man-hour Paid of Production and Related Workers,
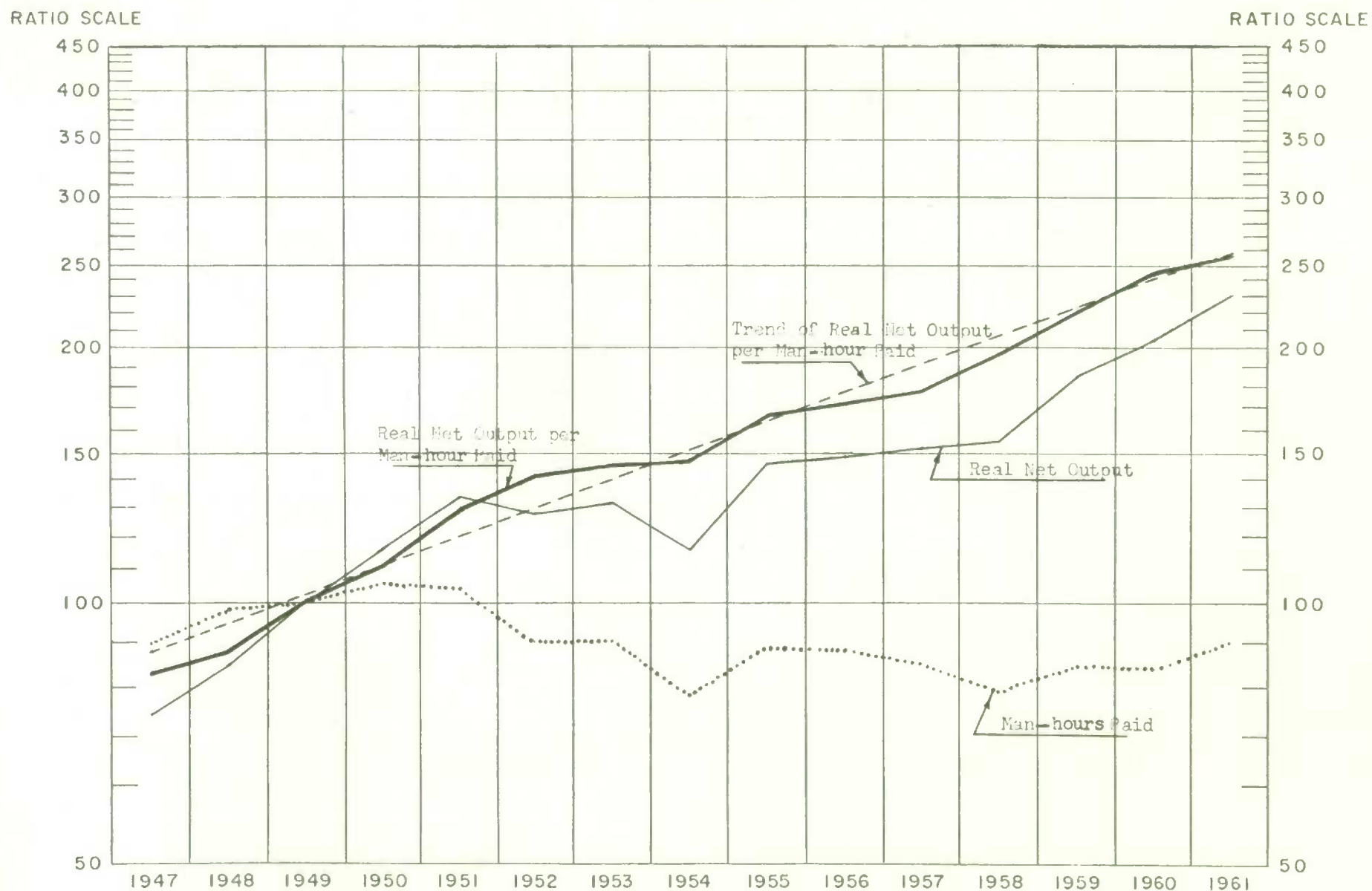Synthetic Textile Mills, Old Basis, Canada, 1947-61
(1949 = 100.0)

CHART 12. Indexes of Real Net Output per Man-hour Paid of Persons Employed,
Synthetic Textile Mills, Old Basis, Canada, 1947-61
(1949 = 100.0)

PART IV

GENERAL TECHNICAL NOTES

PART IV

GENERAL TECHNICAL NOTES

Basic Concepts and Methods

Introduction

The various indexes of output per unit of labour input presented in these reports seek to measure the changing relationship between the volume of output in the industry each year and the labour time which is expended in its production. Each index is derived as the quotient of a base-weighted (Laspeyres) index of real output and an unweighted index of labour time and thus reflects the joint effect of all contributing factors, of which the skill and effort of the labour force itself is only one.

Attempts to take into account the influence of inputs other than labour time may take the form of their actual measurement and embodiment into further partial or "total factor" productivity ratios. Alternatively - and this is the approach adopted in these reports - the appraisal may be qualitative in character, making use of data such as those relating to capital and repair expenditures for descriptive purposes.

Output

The basic concept of output used in these reports is that of Gross Domestic Product at factor cost by industry of origin. Prior to 1961, in the case of industries covered by the Annual Census of Manufactures, this embraced manufacturing activities only. Beginning in that year, the concept has been widened to include all revenue producing activities of which, however, nonmanufacturing activities normally comprise only a relatively small part. For the time being, these reports deal only with manufacturing activities.

Gross Domestic Product originating, or net output as it may conveniently be called at the industry level, is, in the manufacturing industries, essentially a

measure of the contribution of the factors of production which are utilized in the

transformation of raw materials into finished output. In practice, this concept

has to be approximated by the alternative of "census value added" which tends to

overstate net output to the extent that certain purchased services are not excluded

from the former. Net output (census value added) cannot be expressed in real terms

directly but only by the "double deflation" technique in which aggregate measures of

gross output and intermediate inputs (materials, fuel, etc.) are separately calculated

in real or constant dollar terms and the latter subtracted from the former.(1) For

this purpose, quantities of the various products and intermediate inputs of each

year are weighted by the average unit values prevailing in the base year.(2) The

algebraic formulation of the "double deflation" index of real net output by what may

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(1) The meaning of the terms "gross" and "net" as used here differs from that which
    prevails in the context of the National Income aggregates, where they denote the
    inclusion or exclusion of capital consumption allowances.

(2) The details of the actual procedure (Revised Index of Industrial Production,
    1935-57, DBS Catalogue No. 61-502, page 26) have been summarized as follows:

    "The first step was the tabulation, for each year of the period covered,
    of the quantities and values of products, materials, fuel and electricity, (and)
    the opening and closing inventories of finished goods and goods in process .....
    the tabulated material was given a preliminary examination in order to discard
    any obviously defective data or items which lacked continuity or had been affected
    by changes in classification. .... The total value for each item in the base
    period was (then) divided by the total corresponding quantity, giving a fixed
    unit value for the item. The quantity in each year of the period covered by the
    index was multiplied by this fixed unit value. After each item in the industry
    had been treated in this way, a sum was taken, for each year, of the values at
    constant prices. At the same time, the values at current prices of the same
    items were also summed. The division of the latter figure by the total current
    value of the industry in each year gave the percentage of coverage. The sum of
    the values at constant prices of the covered items was then divided by this
    coverage ratio. .... The resulting "blown up" aggregate in each year was then
    divided by the aggregate in the base year to derive the physical volume index.
    This procedure was applied to the products, materials and fuel and electricity
    of the industries for which these data were available."
    See also Appendix A for a simplified example of the worksheet procedure.

be called the commodity approach (commodity net output) is as follows:

$$I_{CNO} = \frac{\sum Q_1 P_o - \sum q_1 p_o}{\sum Q_o P_o - \sum q_o p_o}$$

where P and Q are the average unit values and quantities of products, p and q are the average unit values and quantities of intermediate inputs, and the subscripts "o" and "i" indicate the base-year and given-year values respectively.

As a supplement to the index of real net output and in some cases as a substitute for it, the index of real gross output by the commodity approach (commodity gross output) is also presented in this report.

$$I_{CGO} = \frac{\sum Q_1 P_o}{\sum Q_o P_o}$$

In its substitute capacity, the gross output concept will be used as an exclusive vehicle for productivity measurement when the value data on intermediate inputs cannot be separated into unit value and quantity components in sufficient detail and when there is no prima facie evidence that the index of real net output, had it been available, would have moved over time in a manner significantly different from that of real gross output. However, even where it is known that there are discrepancies arising from such causes as changes in the amount of duplication or processing, speical efforts are made, where possible, to apply compensating adjustments to the gross series.

When used in conjunction with the index of real net output, the gross index has extremely useful analytical properties, permitting, for instance, the quantification of trends towards increasing vertical integration which could otherwise be appraised only qualitatively. The effects of more efficient utilization of materials, which would probably be extremely difficult to verify in any other way from the available data, may also be assessed.

It will be readily apparent that the two indexes just described can also

be derived by deflating current dollar values of output and intermediate input with currently-weighted price indexes and, provided the price and quantity components of the basic data are identical in concept and coverage with those of the commodity approach, the formulae below for I_{DNO} (deflation net output) and I_{DGO} (deflation gross output) should yield results identical with those previously outlined:

$$I_{DNO} = \frac{\left(\dfrac{\sum P_i Q_i}{\dfrac{\sum P_i Q_i}{\sum P_o Q_i}}\right) - \left(\dfrac{\sum p_i q_i}{\dfrac{\sum p_i q_i}{\sum p_o q_i}}\right)}{\sum P_o Q_o - \sum p_o q_o} \equiv I_{CNO}$$

and

$$I_{DGO} = \frac{\left(\dfrac{\sum P_i Q_i}{\dfrac{\sum P_i Q_i}{\sum P_o Q_i}}\right)}{\sum P_o Q_o} \equiv I_{CGO}$$

In practice, of course, such an identity of results is impossible to achieve due to such factors as the use of base-weighted price indexes, varying levels of commodity detail in price and production statistics, differences between average unit values and price quotations for comparable commodities and so on.

Input

The basic concept of labour input utilized in this report, i.e., labour time, may be measured either by the man-years or man-hours expended within the industry concerned. The latter may be expressed either by measures of man-hours worked or man-hours paid. Indexes of labour input based on these several alternatives will vary on account of changes in hours worked per week and in the length of paid vacations, sick leave, etc. Before the Second World War, the difference between hours worked and hours paid was of little significance, but changing practices in this area since that time have made the distinction an important one. From the standpoint of defining a purely physical relationship between output and labour time, hours worked

may be the more appropriate concept, while hours paid emphasizes the economic aspect of the relationship. In this report, both are shown to the extent that adequate measures are available.

Since even small errors in the component parts of the productivity ratios can result in significant distortion of the changes which the ratios ought to indicate, it is desirable that the measures of labour time should match the output to which they are related as closely as possible. In some cases, output is reported for a different time period than input, however, this problem varies in importance from industry to industry. As will be apparent from the description of sources below, this problem is minimized in practice.

Until comparatively recently, it seemed that the average annual employment and man-hours of production workers only could be taken as representative of the trend over a period of years in the labour input of most industries, since office staff and other nonproduction workers were comparatively few in number and their relative importance changed only slightly. More recently, however, the proportion of nonproduction workers in the labour force has increased quite markedly. This has generally been associated with the quickening pace of technological change and the growing importance of the marketing function. This raises the question of whether the traditional distinction between production and nonproduction workers still continues to be valid in the light of the fundamentally different industrial structure which seems to be emerging. From this point of view, then, it is desirable to have available more widely defined measures of input and output embracing "total activities".

The preceding discussion on output recognized the need for a weighting system that would appropriately combine a set of heterogeneous outputs into a single measure. The labour inputs associated with those outputs may be equally heterogeneous and for certain purposes it may be desirable to weight them also. The point is frequently made in connection with the construction of aggregate productivity

measures when the labour inputs of a number of industries are to be combined, but it may be just as valid for intra-industry differences in labour inputs at the individual industry level. There are, however, a number of conceptual and data difficulties which make the weighting of labour inputs extremely difficult in practice. For instance, the rate of compensation which includes fringe benefits might appear to be a useful concept for this purpose, but information on the latter which are gradually becoming a more important component of total compensation, is extremely scarce. Again, geographical differentials in compensation for the same job are quite commonplace. Finally, the compensation of labour is not necessarily proportionate to the effectiveness and quality of the work performed. In view of the above considerations, only unweighted measures of labour input have been used in these reports. In fact, for some practical uses such as the forecasting of employment, these unweighted measures may be considered as more suitable.

Sources and Measures

Census of Manufactures

The primary source for the measures of output and intermediate input of the industries dealt with in these reports is the Annual Census of Manufactures, the results of which are available for the whole of the period covered in a form more or less suitable for productivity measurement purposes.

Real Gross Output - For the measurement of real gross output as previously defined, the Census compilations provide specific product detail in quantity and value terms by industry which is usually extensive enough to permit the calculation of a reliable aggregate according to the methods and subject to the precautions which have been described elsewhere.(3) Until about 1952, this detail was requested in terms of

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(3) Dominion Bureau of Statistics, Revised Index of Industrial Production, 1935-57, DBS Catalogue No. 61-502. In that publication, annual net and gross indexes based directly on Census data (bench-mark indexes) are generally not available after 1953 since which time the monthly indicators have been used to project annual levels. Measures of output in these reports are based on intense scrutiny of the bench-mark indexes which in due course will be updated.

actual production of the commodities concerned. Since that date, in recognition of the fact that respondents can usually supply data on values of shipments more readily than on values of production, the product detail has been on a shipments basis. This has necessitated adjustments for changes in the inventories of finished goods and goods in process at the aggregate level without, however, any significant loss of accuracy of the output measures. Until 1960, the main emphasis in the Census of Manufactures was on manufacturing activities and the measures of real gross output have been calculated accordingly. Since 1961, respondents to the Census have been asked to report on the total operations carried on within their accounting boundaries, with manufacturing activities reported separately, and the measurement of real gross output will therefore eventually be extended to include such other revenue producing activities as the shipment of goods not of own manufacture, the production of fixed assets for own use, the sale of electricity, etc. These broader measures will be reported side by side with the measures of manufacturing only, each being related to the appropriate measures of labour input.

Real Net Output - As already mentioned, the concept of Gross Domestic Product originating by industry must be approximated by "census value added", and the calculation of real net output indexes therefore necessitates the assembly of base-weighted volume measures of intermediate inputs. As in the case of products, the Census compilations also generally provide commodity detail by quantity and cost for the materials and supplies used in manufacturing operations. These data have always been requested on a "used" basis so that the question of adjustment for inventories should not arise in this case. The percentage of coverage which it is possible to achieve in the process of developing a volume index of materials and supplies other than containers is frequently not as high as that which can be obtained from products. In the case of assembly-type industries, for instance, the value of many purchased components cannot be related to any meaningful measure of quantity. Often the limitation lies in the make-up of the Census schedule itself

which was not primarily designed for this type of analysis. In future revisions of the schedules, consideration will be given to the requirements of productivity measurement, and some improvements have in fact already been effected.

Census information on containers and packaging materials is available in value terms only and, in the absence of suitable price indexes for deflating the reported costs, it has been found necessary to project the base-year figures according to the movements of the real gross output index. This is an unsatisfactory procedure which can only be justified when the proportion of containers and packaging materials to total materials and supplies is small enough for the resultant aberrations from a true volume measure to have an insignificant effect on the index of real net output. The only immediate prospect of any improvement in this area of measurement lies in a detailed survey of expenditures on containers and packaging materials which has recently been undertaken in connection with the 1961 input-output table, and which may afford a basis for the construction of fixed-weight price indexes in some industries for the deflation of their current values.

For the period covered, information on the purchase of electricity is available from the Census in both quantity and value terms so that an accurate volume measure can be constructed by multiplying current quantities with base-year unit values. The Census schedule currently provides for the detailed reporting of various types of fuel used in terms of both quantity and value but unfortunately the information is not available for certain years, so that it has been necessary to construct the volume measures by deflating reported current values with specially constructed price indexes. These will be described in the Industry Technical Notes.

Finally, it may be noted that the broadening in scope of the Census of Manufactures since 1961 will necessitate that the materials and supplies which correspond to the additional nonmanufacturing activities previously discussed be also taken into account in order that a measure of real net output consistent with the total activity concept of "census value added" can, if possible, be determined.

Employment - The preceding discussion under "Basic Concepts and Methods" referred to
the need for measures of labour input in terms of both production and nonproduction
workers. The classification of persons engaged in manufacturing operations used by
the Census of Manufactures until 1961 distinguished between "working owners and
partners", "administrative and office employees", and "production and related
workers". The first category related to unincorporated companies only and therefore
varied in importance according to how prevalent this form of organization happened
to be in a particular industry. "Administrative and office employees" were defined
as including "all executive and supervisory officials, such as presidents, vice-
presidents, secretaries, treasurers, etc., together with managers, professional em-
ployees, superintendents and factory supervisors above the working foreman level
and their clerical staffs". "Production and related workers" was essentially a
residual category, covering all factory workers in manufacturing operations not
otherwise reported, whether paid on a monthly, weekly, hourly, or piece-work basis.
Specific classes of workers defined as falling into this category were "working
foremen doing similar work to that of employees they supervise; also maintenance,
warehousing and delivery staffs, etc."

It seems reasonable to identify the second and third of these categories,
i.e., "administrative and office employees" and "production and related workers"
with the concepts of nonproduction and production workers in manufacturing operations
respectively, in spite of the fact that some of the labour time of administrative
employees would actually be expended outside the area of manufacturing operations.
The first category, "working owners and partners", is difficult from the point of
view of classification, since by definition they are almost certain to be engaged
in both production and nonproduction activities. Their status can best be re-
solved in practice by including them in measures of total employment in manufacturing
operations, although they too may be partly engaged in nonmanufacturing operations.
Before 1961, outside piece-workers were also reported to the Census of Manufactures

but were classified separately from the total of manufacturing employment. The
importance of such employment is very slight in the majority of manufacturing in-
dustries but, to the extent that their output and the intermediate inputs used by
them are included in the numerator of productivity ratios, proper matching requires
that the corresponding labour time be included in the denominator also.

There exists yet a further category of employed persons who may contribute
to manufacturing output, namely, unpaid family workers. Unfortunately, neither the
Census of Manufactures nor any other establishment survey conducted by the Bureau
collects data on this category of employment. Unpublished data from Labour Force
Survey sources, however, suggest that unpaid family workers are relatively un-
important in manufacturing. On the basis of the average of the survey weeks of
February 21, May 16, August 22 and November 14, 1959, they comprised only 0.23% of
persons employed in manufacturing.

Since 1961, as a consequence of the change in emphasis in the Census of
Manufactures from activity statistics to establishment statistics, manufacturing
operations are no longer identified as a separate area of employment in recognition
of the fact that administrative and office employees cannot be properly allocated.
The schedule still continues to distinguish production and related workers engaged
in manufacturing operations, but there is no provision for the allocation of ad-
ministrative and office employees to separate activities so that the next step has to
be to an all-embracing measure of total employment which includes, as well as working
owners and partners and administrative and office employees, sales and distribution
workers, employees in new construction, outside piece-workers and other production
and related workers. Such a broad measure as this can be meaningfully related only
to total output, net or gross, as previously discussed. Thus, all future compilations
will be in terms of output per production and related worker in "manufacturing
activities" and output per person employed in "total activities".

It should be pointed out that, with the exception of production and

related workers in manufacturing operations, all the measures of employment so far referred to are based on averages reported for a complete year. The figures for production and related workers, on the other hand, are averages of the numbers of employees reported as receiving pay during the last pay period of each month. This raises certain questions as to the relative reliability of the two kinds of measures which are discussed further below.

Man-hours - Man-hours of production and related workers in manufacturing have been collected in the Census of Manufactures since 1956, the annual totals being the sum of four separate quarterly estimates. Respondents are required to indicate for each period the total man-hours at work, the total man-hours not worked but nevertheless paid and the grand total of all man-hours paid.

Summary - The various combinations of output and input which can be derived directly from the Census of Manufactures for productivity measurement at the 3-digit industry level are summarized in the following table. Not all of them are necessarily logical or useful. For instance, it would be difficult to interpret the ratio of real gross or net output (total activities) to the man-hours of production and related workers only.

Secondary Sources

Price Indexes - As is noted in Table IIIa, on the following page, measures of real output, both net and gross, can be derived either by the commodity approach or by the deflation of current dollar values of output and intermediate input with appropriate price indexes. However, just as the Census of Manufactures data were not primarily collected for the purpose of real output measurement, neither are available price indexes primarily constructed for the express purpose of deflation. Thus, both approaches usually fall short of the requirements for complete parallelism of results. Until quite recently, for instance, wholesale price indexes in Canada were classified by commodity and, apart from questions of conceptual consistency, their coverage was usually too restricted to permit the construction of indexes for

TABLE IIIa. Availability of Material for Industry Measures of Output
per Unit of Labour Input, Census of Manufactures

Output / Input	Employment				Man-hours	
	Production and related workers (mfg. activities)	Adminis-trative and office employees (mfg. activities)	Total (mfg. activities)	Total (total activities)	Man-hours worked, production and related workers (mfg. activities)	Man-hours paid, production and related workers (mfg. activities)
Real gross output (mfg. activities) ...	1947 to date	1947-61	1947-61	1961 to date	1956 to date	1956 to date
Real net output (mfg. activities) ...	"	"	"	"	"	"
Real gross output (total activities) ..	1961 to date	..	..	"	1961 to date	1961 to date
Real net output (total activities) ..	"	..	..	"	"	"

deflation purposes at the industry level where a considerable degree of heterogeneity in the commodity detail usually exists.

However, the recent publication of a set of wholesale price indexes for manufacturing industries, compiled and presented at the 3-digit level of the Standard Industrial Classification, affords a much more realistic basis for such procedures. This system of industrial price indexes(4) does not as yet cover all manufacturing industries and is limited to products shipped, so that its usefulness is so far confined to the construction of indexes of real gross output. Also, the historical range of the indexes extends no further than the year 1956, which is rather too brief a time span for the purpose of these reports. Another deficiency of the indexes, from the standpoint of their use in the deflation of the current value of output, is that they are base-weighted, whereas the requirements of this procedure call for a currently-weighted price index if deflation at the aggregate level is to result in a measure of real output which is strictly comparable from year to year. The desired effect could be substantially achieved if it were possible to deflate output at the individual commodity level. However, the possibilities of such an approach are restricted in practice because of the limited commodity coverage within particular industries. Nevertheless, limited experience so far has shown that, in those industries where the amount of commodity detail is not extensive enough to permit complete confidence in the results of the commodity approach, the calculation of an alternative index by the price deflation approach may be instrumental in identifying areas of difficulty and in providing a starting point for their clarification. Some of the specific problems involved in the use of these indexes will be discussed in the industry section of these notes.

Work presently under way and directed towards the improvement and extension of the Industry Selling Price Indexes will undoubtedly extend their usefulness in the

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(4) Dominion Bureau of Statistics, Industry Selling Price Indexes, 1956-59, DBS Catalogue No. 62-515.

area of real output measurement. For instance, preliminary steps have been taken in connection with the rebasing of the published indexes to a 1961 weight base and a programme of assembling material input price indexes has been under way for some time. The period prior to 1956 still remains a problem, although in some cases it is possible to construct substitute indexes for the deflation of gross output at least from other sources of price data. For such indexes to be considered acceptable, it is a minimum requirement that their movements roughtly match those of the Industry Selling Price Indexes during the period of overlap.

The calculation of volume measures of fuel used calls for the deflation of currently reported values by means of specially constructed price indexes, the component elements of which, such as natural gas, fuel oil, bituminous coal, etc., are drawn from the general wholesale price indexes(5) and currently weighted according to their relative value as reported to the Census.

Monthly Employment Survey - Another major source within the Bureau has been drawn on for the purpose of further developing the labour input data of the Census of Manufactures. The Employment Section of the Labour Division conducts a monthly survey in which the establishments employing 15 persons and over across a broad industrial composite which includes manufacturing are asked to report separately the numbers of "wage-earners" and "salaried employees"(6) drawing pay in the last pay period of each month together with the corresponding total of wages and salaries and, in respect of those wage-earners for whom they keep records of hours paid, separate figures of man-hours and wages.

The results of the Employment Survey are published monthly by industry(7) and include annual averages of average weekly hours and average hourly earnings of

(5) Published up to 1952 in "Prices and Price Indexes, 1949-52", DBS Catalogue No. 62-501, since which time the detail has been made available from unpublished sources.
(6) These two categories correspond roughly to the "administrative and office employees" and the "production and related workers" of the Census of Manufactures.
(7) Dominion Bureau of Statistics, Employment and Payrolls, DBS Catalogue No. 72-002. - Man-hours and Hourly Earnings, DBS Catalogue No. 72-003.

wage-earners from whom hours are recorded.(8) This suggests the possibility of two alternative means of estimating the man-hours paid of production and related workers in manufacturing operations for the years prior to 1956 when the man-hour questions were first included on the Census of Manufactures schedule. The first of these is the "pay deflation" method, i.e., the division of Census wages of production and related workers by the average hourly earnings of Employment Survey wage-earners, while the second or "employment inflation" method consists of the multiplication of the average number of production and related workers according to the Census by measures of total hours per annum derived from the Employment Survey. In connection with these procedures, the data from Census and Employment Survey sources are not strictly comparable for the following reasons: (a) differences in industrial classi- fication(9) (b) differences in establishments covered, (c) the definition of wage- earners in the Employment Survey is restricted to those for whom records of man-hours are kept, and (d) differences in activity coverage, that is, the definition of pro- duction and related workers in the Census is narrower than that of wage-earners in the Employment Survey in that the latter covers total activities rather than just manufacturing activities.(10) At the level of total manufacturing the wage-earners for whom records of hours are kept comprised, in 1957, some 83% of the annual number of production and related workers reported to the Census of Manufactures so that, in those industries where establishments employing less than 15 persons do not form a significant proportion of the total, there is sufficient common coverage to ensure that the average weekly hours and average hourly earnings of the Employment Survey are reasonably representative.

Secondly, it should be noted that the "average weekly hours" of the

(8) Dominion Bureau of Statistics, Review of Man-hours and Hourly Earnings, DBS Catalogue No. 72-202.
(9) As the result of a project currently under way, the Employment Survey classifi- cations will be revised in conformity with the 1960 S.I.C. and the historical data for a number of years will be made available on the new basis.
(10) Since 1961, the Census of Manufactures covers total activities as a result of the introduction of the New Establishment Concept.

Employment Survey are actually "hours paid" since they are defined to include any

hours credited to wage-earners absent on leave with pay in the reported pay periods.

Thus, when the "employment inflation" procedure is carried out for a particular in-

dustry, an estimate of the total hours paid is derived. Similarly, the gross wages

reported to the Employment Survey for the full-time and part-time wage-earners whose

hours are reported also include those amounts credited to wage-earners on leave with

pay so that when the resultant annual averages of hourly earnings are divided into

Census payroll of production and related workers, which is also defined to include

payment for hours not worked, an estimate of total hours paid again results. The

"pay deflation" method is generally considered to be more satisfactory than the

"employment inflation" method because the payroll figures of the Census of Manufac-

tures cover the entire year whereas the employment data, being based on the average of

monthly sample periods, are subject to possible imperfections. However, the above

qualifications do not always hold and in some cases, the "employment inflation"

method is found to be more acceptable. These considerations have been confirmed by

actual comparison of reported and estimated man-hours by the two methods in a number

of cases at the individual industry level.

Since the man-hours paid of production and related workers before 1956

can be satisfactorily estimated, it might seem desirable to extend the process still

further and estimate also the man-hours not worked but paid in each year so as to

derive, by subtraction, the man-hours worked. Unfortunately, there are no quanti-

tative data in Canada on which such an estimate can be based. As is shown later in

these notes,(11) the Department of Labour has published information on the provisions

for paid holidays and vacations with pay in Canadian industry, but not in a form

suitable for estimation of man-hours worked. It may be mentioned that this limitation

also applies to the estimation of the man-hours paid of administrative and office

employees for all years.(12)

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(11) See page 90 below.
(12) See Annual Survey of Employment, page 87.

The availability of employment data from the Monthly Employment Survey, simultaneously with those of the Census of Manufactures, permits a check on the accuracy of both. When, at the individual industry level, the published Employment Survey annual average of wage-earners for whom records of hours are kept is subtracted from the annual average of total wage-earners and salaried employees,[13] a figure is derived which represents the sum of salaried employees and those wage-earners for whom hours are not kept. The two components can then be compared with the numbers of production and related workers and administrative employees reported to the Census. Significant differences in year-to-year changes between corresponding components can then be further investigated by comparison of source data at the establishment level, as a result of which differences in establishment and activity coverage, etc. can be made explicit and allowed for. Detailed reconciliation studies of this kind are time-consuming but result in considerable improvement in the quality of the data when ambiguities in the data of both sources can be identified and clarified with respondents.

Annual Survey of Employment - The Monthly Survey of Employment, Payrolls and Man-hours is supplemented by an Annual Survey[14] conducted in October of each year, which is the only source of data on the average hours and average hourly earnings of salaried employees in manufacturing. This makes it possible to derive, at the individual industry level, estimates of man-hours paid for salaried employees by the methods previously described. Such estimates differ from those which are derived for production and related workers in that the inflators and deflators are based on the data of a single sample week in October of each year. The existence of any seasonal pattern in the average hours paid and average hourly earnings of salaried employees, such as may characteristically occur for wage-earners in certain manufacturing industries, cannot be confirmed or denied statistically but seems less

(13) Dominion Bureau of Statistics, Review of Employment and Payrolls, DBS Catalogue No. 72-201.
(14) Dominion Bureau of Statistics, Earnings and Hours of Work in Manufacturing, DBS Catalogue No. 72-204. 1961 and 1962 were not surveyed.

likely in practice. Furthermore, although there is a long-run tendency towards a
shorter work week, it is not sufficiently pronounced to cause any significant differ-
ences between the figures reported for the survey week and the corresponding annual
averages that would result from the availability of monthly data. Average hourly
earnings, however, have tended to increase over most of the period in question, with
year-to-year changes big enough to invalidate the use of October figures as rep-
resentative of annual averages. Wherever it seemed warranted, adjustments have been
made to the published figures of average hourly earnings to correct for this sus-
pected upward bias.

In the case of administrative and office employees, as with production and
related workers, there is a presumption in favour of "payroll deflation". However,
a comparison is made between the results of the two methods and after consideration
a proper choice is arrived at. It should be noted that the man-hour estimates for
administrative and office employees cannot be compared with reported man-hours.

Department of Labour Publications - Two publications of the Economics and Research
Branch of the Department of Labour should also be mentioned. "Wage Rates, Salaries,
and Hours of Labour" presents for the manufacturing industries tabulations by selected
3-digit industry of representative occupational wage rates and standard hours per
week on the basis of a survey conducted in the last pay period prior to October 1
each year covering all establishments with 15 or more employees.

"Working Conditions in Canadian Industry" has at various times published
information by 3-digit manufacturing industry for both plant and office employees on
such points as: the standard work week, overtime provisions, paid statutory or public
holidays, vacations with pay, pension plans, group life insurance plans, industrial
medical services, health benefit plans, etc.

While these sources will not necessarily be drawn upon in the preparation
of these reports, they provide a potentially useful supplement to the labour input
data of the various Bureau surveys and "Working Conditions in Canadian Industry" is

particularly interesting in that its findings could provide a starting point for the
estimation of indexes of unit labour costs.

Summary of Available Measures of Output per Unit of Labour Input

By means of the secondary sources just discussed, it becomes possible to
extend considerably Table IIIa above, which indicated the various measures of output
per unit of labour input which could be derived directly from the Census of Manu-
factures data. Because of the desirability of classifying the measures of output and
input by method of calculation, the two cannot be directly related in the same table
and are therefore enumerated separately in Tables IIIb and IIIc. As before, meaning-
ful ratios cannot necessarily be derived for every combination of outputs and inputs.
The ratios which have been chosen as of particular analytical significance are dis-
cussed in Part II of this report and their values, together with those of their
components, are presented in Part III.

Sources of Background and Interpretative Material

In Parts I and II of this report, frequent use is made of supplementary in-
formation for the purpose of describing the characteristics of the industry in
question and of relating it to the 2-digit industry of which it forms a part, as well
as to manufacturing as a whole. The main sources of this information are as follows:

Census of Manufactures - The Census of Manufactures provides a certain amount of
detail which is already embodied in the indexes of real net output per unit of labour
input, but which is also useful in any calculation of related measures such as real
gross output per unit of fuel and electricity or material consumed. Information as
to the composition of the industry by size and geographic location, and such factors
as trends in value added per person employed is also drawn from Census sources.

Capital Expenditures Survey - Another important source for background material is the
annual Capital Expenditures Survey of the Bureau.(15) This survey collects details

(15) "Private and Public Investment in Canada, 1946-57", DBS Catalogue No. 61-504.
     "Private and Public Investment in Canada, Outlook", Annual, jointly prepared by
     the Dominion Bureau of Statistics and the Economics Branch of the Department of
     Trade and Commerce.

TABLE IIIb. Availability of Material for Industry Measures of Output, Primary and Secondary Sources

Calculated by \ Output measure	Real gross output (mfg. activities)	Real net output (mfg. activities)	Real gross output(1) (total activities)	Real net output(1) (total activities)
Commodity approach	1947 to date	1947 to date	1961 to date	1961 to date
Deflation approach	1956 to date	..	1961 to date	..

(1) Or combinations of both approaches.

TABLE IIIc. Availability of Material for Industry Measures of Labour Input, Primary and Secondary Sources

Derived from \ Input measure	Employment				Man-hours				
	Production and related workers (mfg. activities)	Administrative and office employees (mfg. activities)	Persons employed (mfg. activities)	Persons employed (total activities)	Man-hours worked, production and related workers (mfg. activities)	Man-hours paid, production and related workers (mfg. activities)	Man-hours paid, administrative and office employees (mfg. activities)	Total man-hours paid (mfg. activities)	Total man-hours paid (total activities)
Reported data	1947 to date	1947-61	1947-61	1961 to date	1956 to date	1956 to date	..	..	..
Estimated data	..	..	..	..	..	1947 to date	1947-61	1947-61(1)	1961(1) to date

(1) Combinations of estimated and reported data.

of new investment on durable physical assets for construction and machinery and
equipment, as well as repair expenditures necessary to maintain the stock of durable
assets. The concept of investment used is defined in gross terms and embraces durable
physical assets, i.e., those which continue to be used in their original form for
more than one year, the usual accounting period. The data are published primarily
at the 2-digit level of industrial classification and higher, but figures of invest-
ment for the post-war years have been made available at the 3-digit level for the pur-
pose of industry division publications.(16)

Aggregate Productivity Measures - The interpretation of changes over time in ratios
of output per unit of labour input at the individual industry level will undoubtedly
be facilitated by the availability of similar ratios at higher levels of aggregation
in the industrial classification. In this connection, the Bureau has recently pub-
lished indexes of output per person employed and per man-hour worked for the com-
mercial non-farm sector of the economy and its manufacturing and nonmanufacturing
components for the period 1947 to 1963.(17) The manufacturing series will provide
a particularly useful frame of reference for the individual industry measures
presented in these reports.

Special Problems

Changes in the Census of Manufactures(18)

The data compiled on the old basis are fully consistent with the 1948
Standard Industrial Classification and the activity concept while those on the new
basis reflect the 1960 Standard Industrial Classification and the New Establishment
Concept.

(16) See, for instance, "Synthetic Textile Mills", 1960, DBS Catalogue No. 34-208,
     and "General Review of the Manufacturing Industries, 1961", DBS Catalogue No.
     31-201.
(17) Dominion Bureau of Statistics, Indexes of Output per Person Employed and per
     Man-hour in Canada, Commercial Nonagricultural Industries, 1947-63, Ottawa,
     Queen's Printer, 1965, DBS Catalogue No. 14-501.
(18) For a wider discussion of these changes and their implications, see the article
     "Forthcoming Changes in the Census of Industry", Canadian Statistical Review,
     July, 1961 and the introductory notes of any 1962 Census of Manufactures pub-
     lication.

The New Standard Industrial Classification - In 1960, as the first stage in a major
revision of the Census of Manufactures, reporting establishments which had up to that
time been coded according to the 1948 Standard Industrial Classification were re-
grouped to conform with the revised groupings of the 1960 Standard Industrial Classi-
fication. At the individual industry level, this implies the possibility of dis-
continuity in the indexes of output per unit of labour input. The manufacturing
industries most affected by the change are in the group generally known as "durable
goods" industries. In most of the industry studies scheduled for early publication
the problem is either non-existent or of minor importance.

Revisions in Concept - The second major problem for the construction of productivity
indexes which is implicit in the revision of the Census of Manufactures arises out
of the shift in emphasis from the purely manufacturing activities of reporting
establishments to a wider concept of all nonfinancial activities of establishments
engaged primarily in manufacturing. This change, from the activity to the establish-
ment concept, became effective in 1961.

As far as manufacturing activities are concerned, it was formerly required
that manufacturing shipments be reported at an "f.o.b. plant" level of valuation so
as to be consistent with related operational statistics such as employment, payrolls,
materials and supplies, etc. In many cases, however, respondents' accounting records
were not organized on an activity basis and firms operating sales branches and market-
ing divisions, for instance, where significant valuations only emerged at the point
of sale, were not always able to report at the proper level of valuation. Reporting
requirements for the Census of Manufactures have, with some exceptions, now been
accommodated to these realities and the valuation of shipments is now requested
"f.o.b. establishment", i.e., at whatever level the accounting records of the re-
spondents fix the boundary of the establishment.

When the commodity approach to the measurement of manufacturing output in
real terms is used, the average unit values used as weights for particular commodities

will reflect the base-year marketing practices of the various establishments which produce them, and subsequent organizational changes among the establishments, which would show up in the current value of their output, would have no effect on the real measures during the currency of a particular weighting pattern. However, drastic shifts in the contribution to the industry's total output of particular commodities by establishments reporting at different levels of valuation could have effects similar to those which result when, under a uniform concept of valuation, major changes take place in the composition of output and in the corresponding unit values. In both cases, the relative importance of commodities implied in the base-year weighting pattern may no longer be adequate for real output measurement purposes.

When, on the other hand, the price deflation approach to the measurement of real manufacturing output is being used, an organizational change such as the entry into the field of retail sales by manufacturers which would result in an increase in the current value of the output of the producing establishment, would also be reflected in a corresponding increase in the real measure. The problem of maintaining a real measure of purely manufacturing activities thus becomes a problem of adjusting the price index to conformity with the new "marketing mix" of the establishments in the industry. This would, of course, be very difficult to achieve in practice.

Care must also be taken that the differential effects of organizational changes on the labour side do not result in artificial increases or decreases of the productivity ratios because of a mismatching of components. In the example just referred to, there would be an increase in the number of sales and distribution workers which, in the case of a commodity-derived volume measure, would not be accompanied by a corresponding increase on the output side. Under such circumstances, it would be preferable to restrict the denominator of the productivity measure to the employment or man-hours of production and related workers only. In the future, this will be the logical measure. On the other hand, when the real output measure

has been calculated by price deflation, it will, to the extent that the price index has not been correspondingly adjusted, feflect the increase in activity and is thus only suitable for use in measures which compare total output with total employment or man-hours since these also reflect the changes in marketing organization. Individual industries will be carefully scrutinized for changes of this kind and adjustments for continuity made where possible.

The extension of the Census of Manufactures to activities other than manufacturing has already been described earlier in these notes and its implications for the measurement and matching of real output and inputs briefly discussed. It may be pointed out that the problem of compiling statistics on an activity basis which was exemplified by the difficulty of allocating administrative and office employees is no less evident on the output side. Some respondents cannot distinguish in their records between materials, shipments and inventories relating to own manufacturing operations and those relating to their other activities. For these reasons, from 1961 on, complete consistency is more likely to be achieved at the "total activities" level although, even here, certain organizational changes of the kind just noted can make comparisons between the "manufacturing" and "total activities" measures invalid unless proper adjustments are made.

Output per person employed based on "total activities" data will be linked in 1961 to the corresponding series relating solely to manufacturing activities. Consequently, from 1961 on, the output per person employed series will be restricted to "total activities" while productivity in the manufacturing activities will still be measured in terms of output per production and related worker.

Change of Weight Base

As already mentioned, the weight base used in these reports for the construction of real output measures by the commodity approach is 1949. Thus, the latter are consistent with the published measures of real domestic product by industry of origin, and the desirability of a change of weight base in the industry

productivity measurement programme must, in practice, be considered in this wider context. There is considerable evidence at the individual industry level to show that the use of such a remote base has caused varying amounts of distortion in the real output indexes and that an updating is urgently required. The accelerating pace of technological change during the post-war period has resulted in a proliferation of new products and major shifts in the relative importance of old products in the output of many industries. The methodology of the commodity approach allows for the effects of the former by calculating artificial weight bases but the more fundamental solution for both problems is a frequent change of weight base.(19)

International authorities have recommended that the weight base of index numbers of industrial production be reviewed at five-year intervals.(20) It has, however, been for practical rather than a neglect of theoretical considerations that rebasing was deferred until 1961. Limitations on resources made it impossible to rebase the industry of origin indexes to 1957 together with the Gross National Expenditure series. The year 1961 then seemed appropriate for a number of reasons including the fact that the 1961 input-output table would be available to provide the inter-industry weighting system. The choice of 1961 is also consistent with plans for the rebasing of important related series in the area of labour and prices. Again, it seemed desirable to wait until the revised Standard Industrial Classification was put into effect.

The indexes of real manufacturing output per unit of labour input presented in these reports attempt, where possible, to go as far as 1961 on the basis of 1949 weights, the 1948 Standard Industrial Classification, and the manufacturing activity concept in order to provide the maximum amount of continuity of comparable data. As previously noted,(21) this may not always be possible because of classification

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(19) For a more detailed discussion of the impact of these problems on the Synthetic Textile Mills industry and the steps taken to deal with them, see Part V, Industry Technical Notes, pages 107-110.

(20) Statistical Office of the United Nations, Index Numbers of Industrial Production, Studies in Methods, No. 1, New York, UN, September 15, 1950.

(21) See page 94 above, The New Standard Industrial Classification.

difficulties as well as changes in reporting practices arising out of the imple-
mentation of the New Establishment Concept.

The Quality Problem

The effects of quality change on volume and price measures of industrial
groupings of commodities constitute an extremely difficult conceptual and practical
problem which can only be dealt with in an arbitrary manner and to a partial extent,
with a residual warning as to the limited nature of the solution, if any. It is not
the intention here to attempt a comprehensive discussion of this complex topic but
simply to bring to the fore one or two aspects of the problem which have an immediate
bearing on the two general approaches to volume measurement which have been discussed
in these notes and to comment briefly on the manner in which they are or might be
dealt with.

Product Mix - The term "quality change", when used in its broadest sense, actually
embraces a number of logically separate phenomena, some of which are more amenable
to treatment than others. For instance, changes over time in "product mix" can be
described as group or structural quality change. Product mix may be defined as the
proportional composition of the set of distinguishable product "varieties" contained
in a prescribed total or aggregate. The problem caused by changing product mix
occurs for instance when a broadly defined product category in the Census of Manu-
factures schedule for a particular industry, such as "tractors", conceals a gradual
shift from large to small units. In such a case, a volume index based on the total
number of tractors weighted by the base-year average unit value would have a pro-
gressive upward bias.

This kind of quality change is not difficult to deal with in principle
by either of the two measurement techniques. If data for each variety of tractor
within the aggregate are available, then the commodity approach will yield a more
accurate indicator of volume change than could be derived by working at the aggregate
level. Again, the price deflation approach, to the extent that it can be based on

similar commodity detail, will it turn reflect the changing composition of the aggregate.

New Varieties - The preceding illustration assumed that the product mix change referred to was a shift in the relative importance of varieties, all of which were represented in the aggregate over the entire period in question. The introduction of new varieties into the aggregate is a closely related problem, the treatment of which is similar to that for new products. Under the commodity approach, an artificial weight for the variety should ideally be calculated so that it can be explicitly recognized in the volume measure without undue delay. From the standpoint of price deflation, the solution is parallel in nature, namely, to introduce into the index a price quotation for the new variety. In a currently-weighted price index, an artificial price for the base year would have to be estimated. If a base-weighted price index such as the Industry Selling Price Index is being used, it becomes necessary to calculate an artificial weight.

Changes in Components - A further kind of quality change which cannot be handled nearly as well occurs when, for example, what is basically the same model of tractor is improved over the years in some of its minor specifications by means of changes in certain component parts. From the standpoint of the commodity approach, it would be formally correct to regard each change as a new variety. This could conceivably result in considerable discontinuity at the individual commodity level and an extensive reliance on artificial weights, the total effect of which might be somewhat less satisfactory than if no adjustment had been attempted at all.

When such a situation results in an increase in the price quotation for a particular product, conventional methodology in the construction of price indexes permits either of two extreme positions or some intermediate compromise. At one extreme, price quotations of the consecutive varieties may be regarded as directly comparable so that the difference between the two is embodied into the index as pure price increase. Alternatively, the contiguous price quotations may be treated

as directly proportional to the qualities of the varieties concerned so that the
price index registers no increase on this account. When the current value of output
in the later period is deflated by a price index determined according to the second
of these alternatives, the resultant volume measure is higher than that which would
be derived from the use of a price index based on the first assumption.

The Industry Selling Price Indexes previously referred to take an inter-
mediate position between these two extremes with regard to the treatment of quality
change. The convention most extensively used relies on the quantity of direct labour
and materials embodied in each of the two material varieties to be compared as in-
dicators of their relative quality, the precise measure of which is determined by
cost comparisons of common and noncommon components.(22)

For any given industry, it will usually be the case that the appropriate
Industry Selling Price Index reflects to a greater or lesser extent an adjustment
for this kind of quality change, whereas the available data from the Census of Manu-
factures will not permit the kind of adjustment previously suggested for the
commodity approach. Thus, when a gross output index derived by price deflation is
growing faster than the corresponding commodity-based index, it may be the case that
the latter understates the importance of an improvement in quality. From the stand-
point of real product by industry of origin, however, the impact of quality change
must be assessed in terms of the net index. If, for instance, the increase in
quality was known to have originated in a purchased component, it would be clear
that the index of real gross output derived by deflation would overstate the volume
increase, thus, in effect, quantifying the quality change in the wrong industry or
duplicating it. Correct allocation would require the use of a corresponding set of
quality adjusted purchase price indexes, for the purpose of deflating materials and
constructing a net index, as a result of which the impact of the quality change would

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(22) Dominion Bureau of Statistics, Industry Selling Price Indexes, 1956-59, DBS
Catalogue No. 62-515, page 86.

be largely netted out of the purchasing industry's output.

Most discussion of quality change in a context such as the present one is restricted to changes over time in externally measurable physical characteristics which differentiate classes or varieties of related products and which thus can be related to changes in the quantity of primary inputs involved. It thus rules out from consideration the type of quality changes which are rooted in the consumer's subjective attitudes to the products in question and which are therefore thought to be essentially nonquantifiable. An example of such a change would be the case where a product such as a television set was altered in appearance only in order to appeal to consumers. The television might incorporate a number of styling changes such as alterations to the shape and colour of the cabinet which bear no relation to the usefulness of the television and which do not change production costs.

The Reporting Period

Mention has already been made of the importance of properly matched components in indexes of output per unit of labour input. The availability of a common source for the basic data utilized in these reports undoubtedly minimizes this problem, but there remains one aspect of it which may call for adjustment, depending on its severity in particular cases. Respondents in the Census of Manufactures are asked to report their labour input data on a calendar-year basis, but are permitted to report their shipments, purchases and inventory data on a financial-year basis if their accounting period does not coincide with the calendar year and the task of converting to the latter basis is too difficult.

Strictly speaking, the requirements of productivity measurement call for an adjustment of one set of data to the other in all cases where such mismatching has occurred. Practical considerations apart, it would be a matter of indifference which way the adjustment was made, but since the employment figures are reported (production and related workers) by month in the Census and the other data are only available in annual totals, the adjustment can be most easily made to the labour input data. In practice, however, no adjustment will be made where the problem appears to be of minor significance.

PART V

INDUSTRY TECHNICAL NOTES

PART V

INDUSTRY TECHNICAL NOTES

Introduction

In this part of the report, some salient characteristics of the various measures of output and input underlying the productivity indexes for the Synthetic Textile Mills industry and its component branches are described, as well as the difficulties, both conceptual and statistical, encountered in their preparation and the steps taken to deal with them.

It is anticipated that these comments will be of considerable value to users in enabling them to appraise the suitability of the measures for particular purposes. In spite of a common origin in sources such as the Census of Manufactures and the Employment Surveys, it should not be assumed that the measures for different industries are always of comparable and unvarying quality. The nature of the industry may be such that it is difficult to construct a volume measure of output in accordance with the concept described in Part IV,(1) when for instance, custom-made products with a long period of production are involved. Even in the more normal case of the mass production industries, such factors as the introduction of new varieties or completely new products and changes in the relative importance of existing varieties and products pose serious conceptual problems which may be further aggravated by purely reporting and editing difficulties which will vary from industry to industry.

Output

As may be seen from the Tables and Charts of Part III, it was possible to calculate both gross and net measures for the real output of the Synthetic Textile Mills industry and its component branches between 1947 and 1961.

Coverage - Since these measures were wholly calculated by the commodity approach, an

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(1) See Part IV, General Technical Notes, pages 73-76.

important dimension of their reliability lies in the magnitude of the "coverage ratios" underlying the indexes of gross output and materials exclusive of containers(2). The efficacy of the coverage adjustment technique depends on the extent to which the price movements of represented products can be assumed to approximate those of excluded products. Thus there can be no absolute criteria for acceptable levels of coverage, although it has been suggested that, on account of the greater diversity in the nature and origin of unrepresented materials, a much higher level of coverage is required in the measurement of the volume of materials used than would be necessary in the case of gross output where the minimum standard has been set at 50%.(3) From this point of view, the data of Table Va below, relating to the Synthetic Textile Mills industry as a whole, seem acceptable.

(2) See Part IV, footnote 2, page 74 and Appendix A.
(3) Revised Index of Industrial Production, op. cit., page 20.

TABLE Va. Coverage Ratios for Indexes of Real Gross Output
and Materials Used (excluding containers),
Synthetic Textile Mills, Old Basis,
Canada, 1947-61

Year	Coverage ratios	
	Gross output	Materials used
	per cent	
1947	84.11	68.49
1948	87.47	80.10
1949	86.47	78.71
1950	89.98	79.77
1951	87.96	81.08
1952	92.63	83.05
1953	84.13	81.08
1954	86.61	77.63
1955	83.49	78.90
1956	82.55	77.44
1957	82.00	79.09
1958	86.71	74.81
1959	85.92	78.85
1960	86.11	73.95
1961	75.28	69.64

In an industry such as Synthetic Textile Mills, characterized by a con-
tinual tendency towards the displacement of old products by new, increasing remote-
ness from the weight base normally leads to a progressive reduction of the coverage
ratio unless such new products can be brought into the coverage by means of artificial
weights. This was done quite extensively with the result that coverage was well
maintained throughout the entire period. The relatively low coverage ratio for both
indexes in 1961 and for the materials index in 1947 was caused by the use of Census
schedules in which the commodity detail was classified somewhat differently than
during the remainder of the period. On the new basis of compilation, of course, the
1961 indexes will have an extremely high level of coverage, while those for 1959 and
1960 will be somewhat less broadly based as a result of the break in continuity.

No comparable coverage ratios are presented here for the fibre producing
and fibre processing components of the industry. However, scrutiny of the individual
worksheets indicates that, for both gross output and materials, overall coverage was
certainly higher in the fibre producing than in the fibre processing branch.

Treatment of New Products - Normally, when new products or materials appear in the
commodity detail of the Census of Manufactures subsequently to the year of the weight
base, an attempt is made to include them in the covered portion of the real output
calculations by assigning to them an artificial weight which may be estimated in one
of a number of ways. For instance, there may exist suitable price data by means of
which the average unit value of the newly reported product can be adjusted to an
approximation of its base-year value, or the adjustment may be made indirectly on
the basis of changes in the average unit value between the base year and the given
year of some closely related product.

On the product side, such estimates were made in the case of terylene
singles yarn, woven terylene fabrics, nylon tire yarn, orlon yarn, various nylon
intermediaries and carpets of synthetic fibre. None of these was produced in 1949,
but all became progressively more important over the period in question, to the

point where their exclusion from the coverage would have seriously impaired the value
of the gross output index. The adjustments effected on the materials side were no
less important. Artificial weights were calculated for adipic acid and hexamethylene
diamide, the basic chemicals involved in the production of nylon, dimethylteryphtha-
late and ethylene glycol which are used in terylene, and acrylonitrile which is the
basis of orlon, as well as cellulose acetate flakes, terylene singles yarn and con-
tinuous filament fibreglass yarn.

There is, however, a more fundamental problem arising out of the growth
during the period in question in the relative importance of the true synthetics
which exists quite independently of whether they were produced in 1949 or not, and
which may be summarized as follows.

When a completely new synthetic fibre is developed, it typically goes
through a sequence from low output and high unit value to progressively higher out-
put and decreasing unit value. The high initial unit cost can be partially explained
in terms of cost considerations such as high overhead due to under utilization of
capacity and the fast write-off of research expenditures, and partially in terms of
market considerations. Eventually, the time comes when both the output and unit
value series begin to level off, their subsequent movements being determined by more
normal considerations.

The relevance of these considerations to the construction of gross output
and materials used indexes in real terms is that, if in the year chosen as the weight
base, the unit value, actual or estimated, of any commodity represent an early stage
of the growth sequence, its abnormally high level will build into the index con-
cerned a potential upward bias, the actual extent of which then depends on the rate
of increase of the quantities concerned in subsequent years. The avoidance of such
bias thus depends on the development of a weighting pattern based on a relatively
uniform degree of maturity among all products, both old and new. For the calculation
of real output measures on the new basis, where the weight is 1961, the problem

virtually solves itself since, by this time, most of the new products and materials
under discussion had either reached or were on the threshold of the mature phase of
their development.

In the case of the measures calculated on the old basis, however, which are
the ones analyzed in this report, adjustments were made which, while preserving the
general character of the 1949 weighting pattern, were sufficient to eradicate most
of the bias that would have resulted from an uncritical acceptance of 1949 unit
values, whether actual or as conventionally estimated. Between 1949 and 1960, for
instance, the average unit value of nylon singles yarn decreased by 43.1% while ship-
ments were continually increasing at a rapid rate. During the same period, the un-
weighted average of the three published U.S. wholesale price relatives for nylon
yarn(4) decreased by 18.7%. It was assumed that the development of nylon in the U.S.
had, in the sense previously discussed, reached the stage of maturity by 1949, and
the decrease of 18.7% in its average price was accepted as a fair measure of the
long-term influences at work. This price movement was used to estimate a 1949
average unit value of the Canadian product at a level which substantially discounted
the factors associated purely with the growth process. By way of corroboration, it
may be pointed out that the change over the same period in the average unit value in
Canada of continuous filament viscose yarn, a well established fibre, was almost
identical.

The total effect of all such adjustments is shown in Table Vb below which
compares, over the period 1947 to 1959, indexes of real gross output for the Syn-
thetic Textile Mills industry based on adjusted and unadjusted 1949 unit values
respectively.

It will be noted that the two indexes were reasonably close in level in
the early years but began to diverge after 1954 as the impact of the new products
was increasingly felt. However, it should be remembered that even the adjusted 1949
weighting pattern does not fully reflect the conditions that developed after 1954.

(4) United States Department of Labor, Bureau of Labor Statistics, Wholesale Prices
    and Price Indexes.

TABLE Vb. Indexes of Real Gross Output Using Adjusted and Unadjusted
1949 Unit Value Weights, Synthetic Textile Mills, Canada,
Old Basis, 1947-59
(1949 = 100.0)

Year	Index of real gross output	
	Adjusted 1949 unit values as weights	Unadjusted 1949 unit values as weights
1947	75.3	77.2
1948	87.6	88.6
1949	100.0	100.0
1950	116.4	119.3
1951	129.1	131.1
1952	120.3	124.4
1953	126.4	132.0
1954	115.3	119.2
1955	146.9	155.4
1956	151.4	163.2
1957	157.1	173.2
1958	162.1	183.5
1959	195.2	226.2

Treatment of Fuel Costs - The fuel composite, as reported on the Census of Manufactures schedules, is generally composed of coal, petroleum, wood, and gas products. The coal products group is made up of bituminous, sub-bituminous, lignite, and anthracite coal in addition to coke. Petroleum products include fuel oil and gasoline, while the gas aggregate represents the total of manufactured and natural gas.

For the years 1949 to 1952 inclusive and 1954-55, in the Census of Manufactures reporting requirements, there were no provisions for a distribution of expenditures by major categories, only total fuel cost being asked for. For this reason the current value of fuel expenditures in each year was deflated by means of a price index rather than by the "commodity approach".(5)

The deflation of fuel was done using a composite price index made up from the wholesale price index numbers for coal and petroleum products. Because the wholesale price indexes are base-weighted and due to the fact that the trend has been away from

(5) See Part IV, General Technical Notes, page 80.

coal to fuel oil, the respective indexes were weighted by the current distribution
of expenditures on the two categories of products. For those years where the break-
down was not available, the weights were interpolated. For this purpose, the
petroleum products group includes fuel oil, wood and gas while coal is the same as
previously described above.

The deflation could have been done using a finer breakdown of the different
categories of products, however, tests proved that this would not have given too
significantly different results.

Output in the Component Branches - The procedures involved in the calculation of
real gross and net output indexes for the fibre producing and fibre processing
branches of the Synthetic Textile Mills industry may be described here.

The availability of individual establishment schedules and the reporting
requirements of the Census of Manufactures made it possible to divide the industry
into three separate groups of establishments - the fibre producers, the fibre pro-
cessors and the integrated establishments that produce and further process the basic
yarns and fibres.

To arrive at real gross and net output for the fibre producing establish-
ments, it was possible to assemble constant dollar totals of gross and net output by
establishment according to the procedure illustrated in Appendix A. In the case of
the two integrated establishments, however, it was necessary to split both the output
and intermediate inputs between fibre producing and fibre processing activities
respectively.

On the output side, the Census of Manufactures requests the total yarn and
fibre production, whether for own use or for sale. This was attributed in each case
as output to the fibre producing branch of the industry after first being assigned a
constant dollar value by means of the industry average unit values in 1949 of the
shipped portion of such products. The output attributable to the fibre processing
branch of the industry, based on the further processing of the basic yarns and fibres

produced for own use and purchased from others, was reported in full in the Census schedules and valued in constant dollars in the conventional manner.

The constant dollar value of gross output for the fibre producing branch was thus assembled as the sum of the values for the specialized establishments (those that produce only fibres) and those of the fibre producing activities identified within the integrated establishments. In the case of the fibre processing branch of the industry, the constant dollar value of gross output was arrived at by subtracting from the total for the industry as a whole, the constant dollar output of the fibre producing establishments (excluding integrated establishments), the constant dollar output before the split of the integrated establishments and then adding back the constant dollar value of the separately calculated fibre processing activities of the latter. This method reflects the true growth of the gross output for each branch of the industry. However, as a result of the valuation of the fibres produced for their own use by the integrated establishments, the sum of the separate constant dollar gross outputs of the component branches is larger than the constant dollar gross output of the industry as a whole.

For the calculation of net indexes in constant dollar terms, it was necessary to split between the two branches the reported material usage of the integrated establishments as well as the containers, fuel and electricity. In the case of materials, it was usually possible to identify them as directly applicable to one or the other branches and the other items were prorated on the basis of the relative magnitude of constant dollar gross output. The fibres produced for their own use by the integrated establishments, previously shown as output of the fibre producing branch, were treated as materials used by the fibre processing branch, thus eliminating the duplication previously referred to. In calculating the separate aggregates of constant dollar net output, it was therefore possible to simplify the procedure described for gross output by simply deducting from the industry total the aggregate for fibre producers only.

Input

Employment - The indexes of employment of production and related workers and persons

employed in the Synthetic Textile Mills industry from 1947 to 1961, shown in Part III

of this report, originate in the Census of Manufactures and ought thus to be fully

consistent with the output data from the same source, except to the extent that the

latter may sometimes be reported for periods other than the calendar year.(6) Since

this particular inconsistency can be adjusted if necessary, Census employment data

must, in the light of the importance attached to the proper matching of components in

productivity measurement, be regarded as preferable to other sources. Notwithstand-

ing this consideration, however, it is necessary to be aware of any intrinsic limi-

tations in the data. For instance, the reporting procedures which underlie the

Census employment data(7) give rise to the possibility that the latter are not

necessarily as reliable as the output or payroll data which are based on detailed

accounting records. For this reason, it has seemed desirable to attempt some in-

dependent verification of the Census employment data by means of the corresponding

data from the Monthly Employment Survey and, in Table Vc below, published data from

the two sources for the years 1947 to 1959 are compared.

It is immediately apparent that the alternative estimates for production

and related workers are much closer than those for administrative and office em-

ployees. In this form, however, the data from Census and Employment Survey sources

are not strictly comparable for a number of reasons.(8)

After a detailed reconciliation at the establishment level involving ad-

justments for each of the differences noted in Part IV, a comparison was made of the

employment estimates from the two sources for the period 1956 to 1959. As a result

of these refinements, in the case of production and related workers, the Employment

Survey to Census ratios improved from 94.7% to 99.3% for 1956 and from 94.7% to

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(6) See Part IV, General Technical Notes, page 101.
(7) See Part IV, General Technical Notes, pages 81-83.
(8) See Part IV, General Technical Notes, page 87.

TABLE Vc. Comparison of Published Figures of Employment,
Census of Manufactures and Employment Survey,
Synthetic Textile Mills, Canada, 1947-59

Year	Average number of administrative and office employees, C. of M.	Monthly average of salaried employees, E.S.(1)	Employment survey as % of census of manufactures	Average number of production workers, C. of M.	Monthly average of wage-earners, E.S.	Employment survey as % of census of manufactures
	No.	No.	per cent	No.	No.	per cent
1947	1,627	1,713	105.3	13,101	13,046	99.6
1948	1,963	1,715	87.4	14,134	14,417	102.2
1949	2,650	2,199	83.0	14,178	14,497	102.2
1950	3,333	2,861	85.8	14,622	14,149	96.8
1951	3,278	3,445	105.1	14,719	14,349	97.5
1952	3,388	3,490	103.0	12,335	11,813	95.8
1953	3,286	3,117	94.9	12,437	12,238	98.4
1954	3,478	3,396	97.6	10,184	10,342	101.6
1955	3,846	3,400	88.4	11,562	11,126	96.2
1956	3,976	3,208	80.7	11,718	11,102	94.7
1957	4,026	3,068	76.2	11,225	11,198	99.8
1958	3,726	3,321	89.1	10,710	10,024	93.6
1959	3,967	3,432	86.5	11,037	10,453	94.7

(1) More strictly: Total employees minus wage-earners for whom records of hours are kept.

Sources: Dominion Bureau of Statistics - Annual Review of Employment and Payrolls, DBS Catalogue No. 72-201.
Annual Review of Man-hours and Hourly Earnings, DBS Catalogue No. 72-202.
Annual Census of Manufactures, Synthetic Textiles, DBS Catalogue No. 34-208.

95.3% for 1959. Those for administrative and office employees increased from 80.7%
and 86.5% to 89.9% and 95.8% for 1956 and 1959 respectively.

On the basis of this test, then, the Census employment estimates appear to
be substantially corroborated by the Employment Survey data for the limited period
in question. Scarcity of resources made it impossible to extend the test beyond 1956.
Man-hours - The index of man-hours paid of production and related workers in the
Synthetic Textile Mills industry from 1956 to 1961 was derived directly from the re-
ported data of the Census of Manufactures. Since the latter source also provides
annual earnings and employment data for the same employees, the reported man-hours
could be conveniently verified by the pay deflation and employment inflation methods
previously described.(9)   The two estimated series were compared with the reported
man-hour series for the period 1956-61 and, as a result, pay deflation was favoured
as a means of estimating the man-hours paid of production and related workers for
the years prior to 1956.

In order to provide additional support for the chosen method, man-hours
paid for the years 1947 to 1956 were also estimated by the employment inflation
method and the results compared with the pay deflation estimates. The two series
did not differ significantly; as a matter of fact, they never diverged by more than
$\pm$ 2.5%.

In the case of administrative and office employees, it was necessary to
estimate man-hours paid over the entire period from 1947 to 1961 and both methods
were again used. However, the results proved to be not nearly so close as in the
case of production and related workers, the employment inflation estimates being
invariably lower than those derived by pay deflation, particularly in the earlier
part of the period. Actually, the employment inflation to pay deflation ratio for
man-hours paid were 80.5% and 88.4% in 1947 and 1961 respectively.

The possible causes of the discrepancies are more or less the same as in

(9) See Part IV, General Technical Notes, page 87.

the case of production and related workers. However, a reconciliation between the two sources would have been much more difficult.

Nevertheless, the problem should be looked at in perspective. The disparity between the two alternative estimates of administrative and office man-hours is not of alarming dimensions, except perhaps in the first few years. Furthermore, when these data are combined with those of production and related workers, the relative importance of these two categories is such that the disparity of the former has a much smaller impact at the total level.

APPENDIX A

SAMPLE WORKSHEET PROCEDURE

FOR INDEXES OF REAL NET OUTPUT

APPENDIX A

Synthetic Textile Mills Industry
Sample Worksheet Procedure for Indexes of Real Net Output

		1949	1949 unit value $(2 \div 1) = P_{o(1)}$	1950	1951
Part A (Gross output index):					
1. Q_i - Reported production of woven fabrics, continuous filament rayon	'000 yd.	72,369		74,706	71,491
2. $P_1 Q_1$ - Reported current value	$'000	50,277	0.69473	49,674	47,832
3. $P_o Q_1$ - 1949 unit value x reported quantity	"	50,277		51,900	49,667
1. Q_i - Reported production of woven fabrics, all spun rayon	'000 yd.	17,406		20,993	19,544
2. $P_1 Q_1$ - Reported current value	$'000	12,719	0.73073	17,882	16,382
3. $P_o Q_1$ - 1949 unit value x reported quantity	"	12,719		15,340	14,281
1.)					
2.) Other specified products(2)					
3.)					
(a) $\sum P_1 Q_1$ (specified products)($\sum$ line 2)(2)	$'000	107,325		132,736	149,036
(b) $\sum P_1 Q_1$ (census value of all products)	"	124,125		147,515	169,444
(c) Coverage ratio 100 $[(a) \div (b)]$	%	86.47		89.98	87.96
(d) $\sum P_o Q_1$ (specified products)($\sum$ line 3)(2)	$'000	107,319		129,938	140,987
(e) $\sum P_o Q_1$ (all products) 100 $[(d) \div (c)]$	"	124,111		144,408	160,285
(f) Index : 1949 = 100, 100 $[(e) \div \sum P_o Q_o]$	%	100.0		116.4	129.1
Part B (Materials index exclusive of containers):					
1. q_i - Reported use of acetate rayon yarn, singles	'000 lb.	5,639		5,527	5,884
2. $P_1 q_1$ - Reported current value	$'000	5,517	0.97836	5,231	5,898
3. $P_o q_1$ - 1949 unit value x reported quantity	"	5,517		5,407	5,757
1. q_i - Reported use of rayon staple fibre	'000 lb.	8,960		12,940	14,424
2. $P_1 q_1$ - Reported current value	$'000	3,230	0.36049	4,758	6,165
3. $P_o q_1$ - 1949 unit value x reported quantity	"	3,230		4,665	5,200
1.)					
2.) Other specified products(2)					
3.)					
(a) $\sum P_1 q_1$ (specified materials)($\sum$ line 2)(2)	$'000	35,046		43,441	52,547
(b) $\sum P_1 q_1$ (census value of all materials excluding containers)	"	44,523		54,460	64,811
(c) Coverage ratio 100 $[(a) \div (b)]$	%	78.71		79.77	81.08
(d) $\sum P_o q_1$ (specified materials) ($\sum$ line 3)(2)	$'000	34,508		41,198	43,170
(e) $\sum P_o q_1$ (all materials) 100 $[(d) \div (c)]$	"	43,842		51,646	53,244
(f) Index : 1949 = 100, 100 $[(e) \div \sum P_o q_o]$	%	100.0		117.8	121.4
Part C (Containers):					
1949 value of containers projected on real gross output index	$'000	694		808	896
Part D (Electricity purchased):					
1. q_i - Reported quantity purchased	'000 kwh.	179,056		213,757	201,304
2. $P_1 q_1$ - Reported value of purchased electricity	$'000	1,161	.006484	1,254	1,299
3. $P_o q_1$ - 1949 unit value x reported quantity	"	1,161		1,386	1,305
Part E (Purchased fuel used):					
(a) $p_1 q_1$ - Reported total census value	$'000	2,168		2,512	2,733
(b) Currently-weighted price index (special computation)	%	100.0		104.6	106.4
(c) $P_o q_1$, 100 $[(a) \div (b)]$	$'000	2,168		2,402	2,569
Part F (Net output index):					
(i) $\sum P_o Q_1$ Products $[(e)$ of Part A$]$	$'000	124,111		144,408	160,285
(ii) $\sum P_o q_1$ Materials $[(e)$ of Part B$]$	"	43,842		51,646	53,244
(iii) $P_o q_1$ Containers (Part C)	"	694		808	896
(iv) $P_o q_1$ Electricity $[(3)$ of Part D$]$	"	1,161		1,386	1,305
(v) $P_o q_1$ Fuel $[(c)$ of Part E$]$	"	2,168		2,402	2,569
(vi) Net output in 1949 dollars, (i) - $[(ii)+(iii)+(iv)+(v)]$	"	76,246		88,166	102,271
(vii) Net output index: 1949 = 100	%	100.0		115.6	134.1

(1) In some instances, the base-year unit values used for the calculation of constant dollar values may differ from the 1949 value of $P_1 Q_1 \div Q_1$. The extent to which this has occurred is reflected in the differences between (a) and (d) of Parts A and B above.

(2) Includes all those other reported products (or materials) for which both quantity and value were sufficiently consistent to be usable.

APPENDIX B

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APPENDIX B

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