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The Estimation of Real Domestic Product by Final Expenditure Categories and by Industry of Origin in Canada

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Introduction

THE PURPOSE of this report is to describe the Canadian experience in developing estimates of real output by the expenditure and the production approaches, that is, the deflation of final products and the measurement of real value added by industry. Although we were guided by the conceptual framework implied by the integration of input-output with the main income and product tables, no attempt was made to present the more sophisticated mathematical treatment of the entire system of prices, quantities, and values in national accounts, as developed by Richard Stone and others.[1] Here we are concerned mainly with the measures of output that constitute the numerators of productivity ratios, and the deflation of the factor inputs which constitute the denominators of these ratios is mentioned only briefly.

Industrial output, deflated final products, and input-output have all been developed in close harmony with the general framework and conventions of the national accounts. Within this framework there are choices of concept and procedure on such subjects as factor costs and market prices, national and domestic product, valuation and deflation problems in nonmarket areas of output, and the classification of industrial components. To some extent these choices are affected by uses to which the results are to be put and section 2 is therefore devoted to a closer examination of uses. Section 3 then examines the general concepts and procedures used in measuring both industrial real output and deflated products, with emphasis on

[1] For a mathemetical explanation of the complete system, see Richard Stone, *Quantity and Price Indexes in National Accounts* O.E.E.C. (Paris, 1956). See also, Richard Stone and S. J. Prais, "Systems of Aggregative Index Numbers and Their Compatibility," *Economic Journal*, September 1952 (LXII, 247), p. 565. See also John Kendrick's description of the two output measurements in Volume 22 of this series.

conceptual consistency. Sections 4 and 5 describe the procedures used in each measure in detail, while section 6 brings out some problems that arise as a result of these procedures. The results obtained to date are presented in section 7.

BACKGROUND AND PRESENT STAGE OF DEVELOPMENT

Measurement of physical output in Canada was at first confined, as in most other countries, to the industrial production index. This index, using the formula of value added weights times quantity relatives, was first computed in the early twenties, shortly after the Dominion Bureau of Statistics came into existence. At the same time, the annual Census of Industry was providing current dollar data on value added which lent itself to a "rough estimate" of national income, obtained by adding to the net value of production of the commodity-producing industries an estimate of the production of the service industries. In the late thirties and early war years, these estimates were supplanted by ones emphasizing incomes and expenditures, which continued to be published throughout the war.[2] The postwar emphasis on new and better statistical systems led to the development of a modern set of sector accounts, first published in 1946.[3]

The first set of deflated final product estimates by type of expenditure was prepared in connection with an econometric forecasting model set up as a part of the larger program of studies centering about the official paper on employment policy of 1945.[4] (The latter corresponded in certain respects to the U.S. Full Employment Act of 1946.) The ingredients for a much finer deflation existed in the files of the DBS, and so it developed and officially published the estimates in 1950 as a new feature of the national accounts. Attention at that time was being focused upon quarterly developments, statistically as well as analytically. The deflators were therefore recalculated on a quarterly basis, from 1947 to date, on a 1949 time and weight base. This recalculation was refined still further in detail and superseded existing annual calculations.

Returning now to the industrial production index, a series of revisions designed to improve its coverage and weighting system carried out during the war and early postwar years was followed in 1950 by a complete recalculation (base 1935–39=100), which took into account the formula associated with Geary and Fabricant,

[2] S. A. Goldberg, "The Development of National Accounts in Canada," *Canadian Journal of Economics and Political Science*, February 1949.

[3] *National Accounts, Income and Expenditure, 1938–1945*, DBS (Ottawa, 1946).

[4] *Employment and Income, with special reference to the Initial Period of Reconstruction*, presented to Parliament by the Minister of Reconstruction (Ottawa, 1945).

namely deflated commodity outputs less deflated commodity inputs by industry.[5] It was published in early 1953 and incorporated a considerable number of manufacturing indexes compiled in terms of value added in constant dollars. The monthly indexes were seasonally adjusted by hand methods at the major group level.[6] It soon became apparent that a more recent base period was required and that the use of unadjusted man-hours for a number of industries was imparting a downward bias. A further revision of the index was then undertaken, involving the recomputation on the new 1949 weight-reference base and the development of up-to-date annual benchmarks. For the current period, adjustment factors for man-hours, based on trends in output per man-hour as indicated by the benchmark series, were also developed. At the same time, dependence on man-hour data was reduced by expanding monthly commodity surveys. The revised monthly series were processed for seasonal adjustment on the U.S. Bureau of the Census electronic computer according to Univac Method II. Unfortunately resources were limited, and all this work took more time than expected.

Much more important for present purposes is the expansion of the index to cover all other industries in the economy.[7] This work has been going on concurrently with the revision of the industrial production index. Its main object is to provide a substantially independent estimate of real domestic product via the industry approach, useful partly as a check on deflated final product, but mainly for the industrial detail which underlies the main income and product tables. At the same time that quarterly income and product tables and quarterly deflated products were being developed and gaining recognition as a useful descriptive device around which to marshal the analysis of current economic conditions, the development of the quarterly estimates of real product by industry were being emphasized to provide the missing industrial link. They have been available internally for the past few years, and they have been used in the current quarterly analyses of the national accounts. More refinement and experience will be required before complete details can be officially published.[8]

[5] Solomon Fabricant, *The Output of Manufacturing Industries, 1899–1937*, National Bureau of Economic Research (New York, 1940), p. 25. R. C. Geary, "The Concept of Net Volume of Output with Special Reference to Irish Data," *Journal of the Royal Statistical Society*, Vol. 107, 1944, pp. 251–9.

[6] *Seasonally Adjusted Economic Indicators, 1947–1955*, D.B.S. (Ottawa, 1957).

[7] The Research Department of the Bank of Canada was the first agency to develop an aggregate series of real output and the results of this work were turned over to the DBS for further development.

[8] A first step toward publication was recently taken with the release of a reference paper, *Revised Index of Industrial Production, 1935–1957*, DBS (Ottawa, 1959).

ADMINISTRATIVE ORGANIZATION

At the DBS work on real output has been largely concentrated in the Research and Development Division, which is also responsible for the national accounts, interindustry flow studies, and a program for the development of productivity measures. This centralization facilitates discussion of the many complex conceptual and procedural problems involved and provides an excellent environment for achieving consistency between the various measures so that they can be integrated within a common framework.

Being primarily engaged in the development and operation of broad statistical aggregates, the Division is in a good position to uncover inconsistencies in reported data and to assess the relative importance of gaps in the DBS statistical collection program. It is thus expected to provide assistance and guidance in the improvement of existing series and in the development of new surveys and the subject matter of statistical collection in general.

Uses

Analyses of results may be of two broad types: "normative analyses" or "results statements" tell what happened; "behavioural analyses" attempt to explain why it happened.[9] Although the governmental publications and official analyses seldom reach beyond the normative type, the statistics themselves are used by outside agencies and individuals in a variety of ways, including testing of hypotheses and occasionally approaching the ultimate end of explaining why such and such an event took place.

The descriptive or normative analyses that make use of the real output measures are outlined below in terms of their appearance in such publications as the quarterly national accounts, the annual report of the Bank of Canada, the annual federal budget, and other publications. While these are generally explanations or descriptions of past events, the budget presents an explicit forecast. We therefore go on to discuss other than normative uses, such as the relation of real output measures to short-term forecasting and to long-term projections in general.

OFFICIAL USES IN CURRENT ANALYSIS (PARTICULARLY THE NATIONAL ACCOUNTS)

There are three main uses of industry real output measures:

1. As an independent check on the results of the deflation of gross national expenditure (GNE). The material has been used in this way

[9] Somewhat similar distinctions have been drawn by Ingvar Ohlsson in *On National Accounting*, Konjuncturinstitutet (Stockholm, 1953) and by George Jaszi, Volume 22 of this conference, p. 20.

for some years, as an independent check on the reliability of the year-to-year changes in the physical volume of output as shown by the annual constant dollar gross national product (GNP) series. The GNP series is converted to a gross domestic product (GDP) basis for purposes of the comparison. To date the series have reconciled very closely, and only small differences exist in the annual data. Similar comparisons are made with the results of the quarterly constant dollar GNP. While the series on a quarterly basis have tended to reconcile less precisely, the quarterly real output data have nevertheless proven highly useful as a check on the size and direction of change. Both series are now in course of being seasonally adjusted, and we hope to be able to improve the reconciliation of the quarterly data to a point where two independent measures of real output on a seasonally adjusted basis will be available for publication. While these results are at present only experimental, they have already contributed significantly to our current quarterly national accounts analysis, where it is necessary to make some judgment on the latest quarter-to-quarter change in the volume of output.

2. The material provides highly valuable analytical information on the industrial composition of changes in the volume of total real output. It is used extensively in the national accounts to identify the industrial groups responsible for any strength or weakness in the developing economic situation.

3. Perhaps the deflation of GDP can be developed to the point where meaningful price and volume components can be published on a seasonally adjusted basis. The recent inflationary period has pointed up the need for more precise measures of such components of quarterly movements in the current value GDP. At the present time research is being carried out on the development of Laspeyres-type price indicators to match the various elements of the GDP, and not subject to the quarterly weight shifts which vitiate the implicit price deflators for current price analysis. This new price material, together with the seasonally adjusted real output by industry data and the seasonally adjusted constant dollar data showing the disposition of output by main expenditure categories, will be substantially self-checking, and consistent with the current value series.[10] This interrelated set of price-volume-value data should add powerfully to the tools available for current economic analysis.

Other Official Uses. The annual federal budget and the annual report

[10] Consistent except for adjusting entries, e.g., those due to the use of fixed weight rather than currently weighted price deflators, factor cost versus market price weighting adjustments, and adjustments in specific nonmarket areas of output (all described below).

of the Bank of Canada use the real output measures in a variety of ways to describe the events of the past year and to help in assessing the current economic situation. (Of course, they also include many statistics not described here.) Appended to the budget speech is an "Economic Review" which is usually presented to the House of Commons on the day before the budget, providing the economic background to the budget itself. The following quotation illustrates briefly one particular use of the output estimates: "Assuming normal crops, stable prices, and no untoward external events, I am basing my revenue forecasts on a gross national product of $32 billion, which is about 2 per cent above the level achieved in 1957."[11] The estimates underlying this projection are of course detailed in terms of prices, quantities, and values. From the standpoint of the statistician involved, far down the ladder in the budget-making process, the basic ingredients of prices, quantities, and values must be so designed as to come as close as possible to consistency with one another in leading up to the above value projection. If the product of prices and quantities do not equal the value estimate, then the reconciling differences must be clearly explainable.

SHORT-TERM AND LONG-TERM PROJECTIONS

Econometric models are usually detailed in terms of quantity and price variables, and the interrelationships among these. For example, the production function, which is the final supply relationship, is solely in terms of deflated or real values and man-hours. Similarly, demands are expressed in terms of real quantities, explained by real incomes, price levels, and other causal influences. The equating of global supply with global demand becomes, in effect, a global price level determining equation. It is, in fact, very doubtful if a useful econometric model could be constructed from national accounts' data without first separating these into separate quantity and price components. However, as the prices involved among the separate final expenditure categories vary considerably from one another, additional detailing of the price determining equations would be useful.

The Canadian model referred to earlier treats as exogenous the following variables: investment (based on business men's expectations plus other projections for nonbusiness investment), exports of goods and services, and government expenditures. On the supply side it takes into account the growth of the labor force (man-hours), productivity, and imports. It utilizes a general consumption function. After solution, its results are compared with those of the judgment-type

[11] House of Commons Debates, Vol. 102, No. 27 (Ottawa, 1958), p. 1235.

forecasts made by several specialists. What finally emerges is one projection of the main tables of national income and product.

Long-Term Projections. During the past three years, the statistics of industrial output and deflated final products have been available to a specialized research group engaged in projecting Canadian output at five-year intervals to 1980. The Royal Commission on Canada's Economic Prospects has now published its final report, together with a number of monographs on various special aspects of growth. Chief of these, from the view of using real output measures, is the volume by William Hood and Anthony Scott, *Output, Labour and Capital in the Canadian Economy*.[12] It contains a detailed examination of the concepts and procedures used in setting up industrial real-product and deflated final-product estimates, discusses their suitability for this usage, and presents the record, according to their own worksheets and particular classification scheme, from 1926 to 1955. This record is then used for the 1980 projection. The document contains also some tentative estimates of the real capital stock which were a necessary part of the projection.

USES OF REAL OUTPUT FOR PRODUCTIVITY ANALYSIS

Both output measures described below can be used at the aggregative level in the numerator of a global productivity ratio to derive a measure of total economic productivity. One of the main precautions is that estimates of real product originating in government departments and some minor items of household product embody a constant productivity assumption. This assumption appears also in fixed capital deflators, wherever there are no end prices and factor or material input costs are used to represent them. A proper concept for use in a global productivity measure should be the business sector gross domestic product, divided by corresponding man-hours.[13] This measure incorporates the effects of changing product mix at all levels of aggregation.

Another measurement is that of economic productivity by industries, in which gross domestic product at factor cost originating in each industry is divided by man-hours. If the industry mix is held constant, at the finest or four-digit level, we come as close as possible to a technical productivity concept, which cannot be further refined since our calculations do not generally extend down to plant studies and data on man-hours for individual commodities are not obtainable.

[12] Royal Commission on Canada's Economic Prospects (Ottawa, 1958).

[13] Kendrick, Vol. 22, *op. cit.*, p. 414. Kendrick also favors relating real product at factor cost to the corresponding total real factor cost (including capital as well as labor inputs) to get a measure of "total factor productivity."

Shortcomings for productivity uses are discussed further in sections 4 and 6.

Common Objectives, Concepts, and General Procedures

At the present time we are trying to develop an aggregate measure of total product in real terms. We are not concerned with the problem of constructing real balancing accounts for the entire national accounting system,[14] but are concentrating our resources on expressing, in constant dollars, the consolidated production account, GDP = personal expenditure + government expenditure + business final expenditure + exports − imports. Deflation of the factor incomes and capital consumption allowances that ultimately comprise the left side of the equation is not, at present, considered feasible owing to the ambiguity involved in the choice of deflators. No one yet knows a good way of expressing such components as profits in terms of physical volume. (Indeed, if unique deflators could be determined, an adjustment to the left side for changes in productivity would be required to balance the account in real terms.)[15]

Although the factor shares are not themselves easily deflated, their total for each industry in the form of real value added can be obtained by subtracting deflated inputs from deflated outputs. In this form all commodity and service transactions can be expressed as quantities and as values. In effect, the two approaches are designed to measure the GDP by summing commodities and services in two different ways. The production approach measures commodities and services at each stage of the production process and removes double counting and foreign-produced items as each industry boundary is crossed. The expenditure approach arrives at the same aggregate by measuring commodities and services as they finally emerge, less a lump sum amount for foreign-produced items. This fundamental proposition of equality of the two approaches depends upon having a common definition of output, consistent data, a complete and mutually exclusive classification system, and a specified method of routing (that is tracing commodities and services through the productive and distributive processes until they emerge as final products). The following example is intended for illustrative purposes only.

Suppose that raw sugar is imported, then refined in a factory where

[14] *A System of Price and Quantity Indexes for National Accounts*, Statistical Office of the United Nations (New York, 1958).

[15] The following comment by Kendrick clarifies the position on productivity: "The advantage of deflating both national income and product is that the difference is an efficiency measure. It is not necessary to deflate profits which is one component of capital compensation; rather, base period capital compensation can be extrapolated by an index of real capital stock and services."

factor costs such as wages, rent, interest, and profits are incurred, plus depreciation. The refined sugar emerges in packaged form, is transported to a retail outlet, and sold to the consumer. The process is recorded for two periods of time, period 0 (the base year) and period 1 (the current year), for each of which there exist prices and quantities pertinent to the successive stages of importation, factory shipments, inventory holdings, transportation, and retail selling. To simplify the example, let us assume no indirect taxes, no intermediate inputs into factory production other than raw sugar, no intermediate inputs into transportation, no intermediate inputs into retail selling other than the cost of the sugar and the transportation charges, and no inventory holdings other than refined sugar at the factory valued at average selling prices.

Production Approach

	Period 0	*Period 1*
Refined Sugar Shipments	100 lbs. @ .20¢	150 lbs. @ .30¢
Imports of Raw Sugar	130 lbs. @ .10¢	150 lbs. @ .12¢
Change in Inventory of Refined Sugar	+10 lbs. @ .20¢	−15 lbs. @ .30¢
Transportation of Refined Sugar	100 lbs. @ .01¢	150 lbs. @ .02¢
Retail Selling	100 lbs. @ .25¢	150 lbs. @ .40¢

In the production approach, value added in constant dollars is computed at each stage of production, transportation, and selling, by subtracting from the gross value or revenue in constant dollars (prices of period 0) the cost of materials and services in constant dollars. Since quantities and prices are available at each stage, the constant-dollar aggregate can be obtained either by multiplying the quantities by base-year prices or by dividing the current values by indexes of prices. In the example, the manufacturer of refined sugar was able to extract proportionately more refined sugar from the imported material in period 1 than in period 0 because of more efficient machinery. Results of the computation, in constant (period 0) prices are:

	Period 0	*Period 1*
1. Factory Shipments	20.00	30.00
2. Add Inventory Change	2.00	−3.00
3. Less Materials Used	−13.00	−15.00
4. Value Added at Factory	9.00	12.00
Index (period 0=100)	100.0	133.3
5. Value Added in Transportation	1.00	1.50
Index (Period 0=100)	100.0	150.0
6. Retail Sales	25.00	37.50
7. Less Cost of Sugar	20.00	30.00
8. Less Transportation	1.00	1.50
9. Value Added in Retail Selling	4.00	6.00
Index (Period 0=100)	100.0	150.0
10. Total Value Added (4+5+9)	14.00	19.50
Total Index (Period 0=100)	100.0	139.3

The total index of 139.3 in period 1 could also be obtained by summing the component indexes on the basis of the value added weights in period 0. If data on raw sugar used at the factory were not available in period 1, it would not be possible to reflect the saving in materials consumed in the factory index; based on gross production, the factory index would be 122.7 instead of 133.3, and the total index 132.5 instead of 139.3. An assumption that gross output moved parallel to net output in this case would be erroneous.

Expenditure Approach[16]

	Period 0	*Period 1*
1. Consumer Expenditures on Refined Sugar	25.00	60.00
2. Retail Price Index of Refined Sugar	100.0	160.0
3. Consumer Expenditure in Constant Dollars (1÷2)	25.00	37.50
4. Add Value Change in Inventory (VPC)	2.00	−4.50
5. Price Index of Refined Sugar at Factory	100.0	150.0
6. Inventory Change in Constant Dollars (4÷5)	2.00	−3.00
7. Value of Imports of Raw Sugar	13.00	18.00
8. Import Price Index	100.0	120.0
9. Imports in Constant Dollars (7÷8)	13.00	15.00
Total (3+6−9)	14.00	19.50
Total Index (Period 0=100)	100.0	139.3

Deflation by price indexes is most usual in the expenditure approach, direct quantity measurement most usual in the production approach, because quantitative data are more easily obtainable at the initial stages of production while price series are usually more numerous and detailed at the final stages. There is no reason, however, why either method cannot be used, since, assuming no statistical or other inconsistencies, they provide exactly equivalent answers. Weighting is not illustrated here since only one commodity is involved at each stage. However, if bundles of commodities were being handled, the quantities should be base-weighted where the quantity method is used and the prices currently weighted where the deflation method is used, since the important result is the quantity comparison from period to period. The main point is that the sum (retaining signs) of successive constant-dollar inputs and outputs is equal to constant dollar final product.[17]

GROSS PRODUCT AND NET PRODUCT

The inclusion of capital consumption allowances makes the concept of production "gross." When they are subtracted the product is said to be "net" since it is measured after the deduction of output necessary to replace capital used up during a given period by wear,

[16] In practice, data may not be available at this level of detail.

[17] See Richard Stone, *Quantity and Price Indexes in National Accounts*, OEEC, *op. cit.*, p. 34.

tear, obsolescence, and so forth. For some general purposes the gross meausre is the more significant since it incorporates all the resources used in the process of production.[18] Moreover, there are statistical difficulties involved in the measurement of real capital consumption allowances and the estimates are presently restricted to the "gross" concept.

DOMESTIC PRODUCT AND NATIONAL PRODUCT

It has long been recognized that to measure the contribution of various industries to total production one must distinguish between domestic product and national product, and that an industrial approach requires a measure of output produced within the geographic boundaries of a country (GDP), a national approach a measure of product accruing to its residents (GNP). Although the present official Canadian estimate of real expenditure is in terms of national product, estimates of output by industry are now being developed on the basis of domestic product.

Among the factor costs inextricably mixed with industry value added are interest and dividends accruing to nationals of other countries. On the other hand, interest and dividends received by domestic industries from other countries are not a part of value added. Thus GDP is the concept at which to aim for a reconciliation based on the identity "GDP plus net factor incomes received from nonresidents (mostly interest and dividends) equals GNP."[19]

GDP has the advantage of being measurable by three largely independent approaches—income, expenditure, and industry value added (as pointed out above, the national concept does not flow naturally from the third approach), and makes a better framework than GNP for income and expenditure accounts, real output by industry, and input-output and productivity studies.

In order to reconcile GNE with gross domestic expenditure (GDE), the entries for total receipts and outpayments of interest and

[18] But Kendrick prefers the net measure for productivity work, thinking of capital consumption as a kind of intermediate product input (Volume 22, p. 414).

[19] The recent United Nations document, *A System of Price and Quantity Indexes for National Accounts*, *op. cit.* prepared for the tenth session of the Statistical Commission, points out that an additional adjustment is required if the accounts are to balance in real terms as they do in current dollars. The document suggests that the real measure of GNP should incorporate an item to represent the gains or losses from the terms of trade. The real external account would then be balanced by the identity "exports+trading gains=imports+surplus." This real trading gain cannot be defined uniquely and a conservative value should be chosen for it. GNP in real terms would then be equal to the real value of GDP plus net factor incomes received from nonresidents plus the trading gain. Canadian practice takes no account of trading gains in the estimates of real GNE, but the ingredients are available to users who wish to make the extra calculation.

dividends are deleted from the national estimates.[20] This incidentally relieves us of the ambiguity involved in attempting to deflate these financial items.[21]

MARKET PRICES AND FACTOR COSTS

When considering the contributions to GDP of different industries, output should be valued at factor cost rather than at market prices. Value added at factor cost is the difference between the selling value of an industry's products excluding indirect taxes on these products[22] and the cost of materials and services used in production, including taxes on these inputs. The difference represents the industry's relative contribution to total output and is a measure of resource allocation particularly relevant for productivity studies.

The statistics which form the basis of the production calculations are principally founded on the factor cost definition. The valuation of output in the annual Canadian census of industry, from which benchmark output data for the mining and manufacturing industries are obtained, excludes sales and other excise taxes. Thus practically as well as theoretically, it appeared preferable to base the measures of production by industry and the weighting system on GDP at factor cost. Another consideration was the advantage of making the industry weights invariant to any changes in indirect taxes particularly since the system is changed only periodically.

On the other hand, the real expenditure approach is associated conceptually with GNP at market prices. Furthermore, the statistical data are given as market values and market prices and therefore the most practical procedure is to leave indirect taxes embodied in both the values of the final products and their price deflators. Once this has been done, however, the resulting quantity series can be recombined, using base period factor cost weights. Although present analytical uses of the deflated final products, concerned as they are with final demand analysis, are better served by the market price procedure, future developments should allow for factor cost weighting as well.[23]

[20] The domestic or geographic concept is extended to include the foreign operations of domestically registered air and water carriers and the activities of legations and armed forces situated in foreign countries. Conversely, the domestic operations of foreign-based air and water carriers, together with the activities in Canada of foreign legations and armed forces, are excluded. The main point here is to ensure that the treatment of these activities adopted in the production approach is consistent with the measure of deflated expenditure.

[21] The domestic product concept is described fully in the United Nations' document F.2, *A System of National Accounts and Supporting Tables* (ST/STAT/SER.F/No. 2).

[22] Taxes such as those on property cannot be allocated to individual products and therefore are not deducted.

[23] See also *National Income Statistics, Sources and Methods*, Central Statistical Office, 'London, H.M.S.O., 1956,' p. 40.

For reconciliation purposes, the production measures at factor cost were inflated to a market price basis, rather than the expenditure estimates at market prices deflated to factor costs. Accordingly, a complete set of market price industry weights was developed to re-weight the production indicators. These weights correspond to the detail available in the 1949 factor cost structure used for the production series and were developed from data used in the construction of the interindustry flow table;[24] control totals for this table were obtained from the national accounts. Indirect taxes and subsidies were allocated to the proper industry factor-cost valuations, an admittedly difficult procedure sometimes. However, in the process of constructing the input-output table, very detailed commodity flow studies were made. Where a commodity was produced by more than one industry group, the flows were kept, as far as possible, separate. Thus taxes were allocated to commodities and to the industries producing them. The results, in general, were judged sufficiently reliable to be used for the present purpose. Subsidies were defined as amounts contributed by governments towards current costs of production and indirect taxes as all taxes which are deductible as expenses from gross revenues of business. Accordingly, the subsidies and taxes were allocated on the basis of the industries receiving the subsidies or paying the taxes.

These market price weights were applied to our experimental industry production indexes and the results are compared in Table 1 with those based on the regular factor cost system. The indexes are shown at various levels of aggregation on the base of 1949=100 for the years 1949–56.

Although the two sets of indexes are similar at the composite level,

TABLE 1

The Effect of Factor Cost and Market Price Weights on Production Indexes

	GDP		*Total Manufacturing*		*Nondurable Manufacturing*	
	Factor Cost	Market Prices	Factor Cost	Market Prices	Factor Cost	Market Prices
Weights (%)	100.000	100.000	27.160	29.689	14.644	17.197
1949	100.0	100.0	100.0	100.0	100.0	100.0
1950	106.2	106.1	106.2	106.3	106.0	105.5
1951	113.7	113.1	115.0	113.9	110.8	109.1
1952	120.1	119.6	118.5	118.4	113.2	113.2
1953	124.1	124.1	126.4	127.0	120.2	120.8
1954	122.4	122.6	122.9	123.8	121.2	121.9
1955	134.4	134.6	134.7	135.9	130.4	131.0
1956	145.5	145.5	145.1	146.1	138.1	139.1

[24] *The Inter-industry Flow of Goods and Services, Canada, 1949,* DBS Reference Paper No. 72 (Ottawa, 1956).

TABLE 1 (concluded)

	Foods and Beverages		*Durable Manufacturing*		*Electrical Apparatus and Supplies*	
	Factor Cost	Market Prices	Factor Cost	Market Prices	Factor Cost	Market Prices
Weights (%)	3.789	4.729	12.516	12.492	1.409	1.497
1949	100.0	100.0	100.0	100.0	100.0	100.0
1950	103.8	103.7	106.5	107.5	112.5	113.4
1951	106.8	106.6	119.9	120.6	120.7	121.3
1952	113.5	114.3	124.8	125.5	124.5	127.7
1953	117.4	119.4	133.6	135.6	150.9	159.2
1954	120.6	121.5	124.8	126.3	151.7	161.7
1955	126.8	128.0	139.7	142.6	176.2	191.6
1956	133.1	135.0	153.3	155.8	191.3	202.5

differences appear at lower levels of aggregation. The effects of a major strike in 1951 in the tobacco products industry (subject to heavy excise taxes and duties) on the two series are clearly distinguishable in the first three groupings. In the manufacturing division, the market price series show a tendency to increase at a slightly greater rate than the factor cost series because most of the industries subject to the heaviest indirect taxes (such as distilleries, tobacco products, petroleum refineries, motor vehicle manufacturers, radio, television, and appliance manufacturers) show larger increases in physical output in recent years than the average of all manufacturing industries. This divergence is particularly noticeable for radio and television manufacturers, whose physical output rose by 443 per cent between 1949 and its peak in 1955, compared with a gain of 35 per cent for total manufacturing over the same period. The marked effect of this rapid advance in one component on the production index for the electrical apparatus and supplies industry is shown in the table. The market price index is nearly 9 per cent higher than the factor cost index in 1955 (the reverse effect appeared in 1956 when output of television sets showed a substantial decline). The choice of the factor cost series in this instance would be necessary in a study involving resource allocation.

The use of market price weights in the expenditure approach and factor cost weights in the production approach leaves us open to criticism for conceptual inconsistency. We decided, however, to recognize the different needs of users and prepare the estimates in accordance with the two concepts. The available statistics lent themselves to this dual approach. In any case, for purposes of general economic analysis, where only broad groups of industries and of final demand components are involved, the choice of concept matters little in practice. In order, however, to enable users to assess the significance of differences in definition, the adjustments necessary to bring the two sets of estimates into conceptual agreement will be made explicit in published reports.

Real Output by Industry

As described earlier, the industry production approach aims at measuring changes in the volume of GDP at factor cost. In general the procedure consists of developing indicators of physical volume for each industry, expressing these as index numbers related to a common base period, and then combining the series into a composite total index by means of base-period weights derived from an industry breakdown of GDP at factor cost. Ideally, the industry indexes should reflect changes in real GDP at factor cost. Available statistics, however, do not measure this concept completely (none on purchases of business services by industry and insufficient detail on materials input for many industries) and each industry is represented by an indicator designed to approximate the desired concept as closely as available data permit.

Comprehensive annual census surveys for many industries make it possible to develop annual benchmark indexes which are extrapolated to the current period on the basis of monthly or quarterly data. Periodically, the current indexes are revised according to the latest obtainable data from the industrial censuses. The latest revision of the monthly Index of Industrial Production, for instance, incorporated the results of the most recent annual censuses of the mining, manufacturing, and electricity and gas industries. The more comprehensive and detailed data available for annual and decennial intervals permit the benchmark indicators to conform more closely to the desired concepts than do the current indexes.

CLASSIFICATION AND GENERAL PROCEDURE

The classification framework for the measures of industrial production, for the current dollar industrial distribution of GDP in the national accounts and for the input-output table, comes from the DBS Standard Industrial Classification. The three structures, however, are not forced into a rigid classification framework and sometimes the form of the available statistics or the particular uses to which the series are put require some rearrangement of the classification. For instance, the close integration of the nonferrous metal smelting and refining industry with the metal mining industry and the difficulty of accurately allocating profits and depreciation required that the two industries be combined under mining in the input-output table. However, for the production measures, GDP weights were estimated separately for the two industries in order to allocate them respectively to the manufacturing and mining divisions.[25] Again, in the input-output table, all construction activity (including new construction and repairs by establishments with their own labor force) was classified in the construction industry. In the real output weighting system, estimated production arising from own account repairs was left with the industries originating the work. No data are available to measure this type of production on a current basis, and it is assumed that the amount of such repair activity is proportional to the industry's major activity. New construction by own labor force, however, is assigned to the construction industry to obtain a direct total measure for this important activity.

As noted earlier, the value of GDP at factor cost can be measured either directly by summing the factor incomes and capital consumption allowances for each industry or indirectly by subtracting all intermediate goods and services from the revenue (ex indirect taxes) arising from the production of goods and services in each industry.

In calculating indicators of real output by industry the first method is not practicable since no statistical measures have as yet been developed to express such factors as profits and depreciation in quantitative terms.[26] The second method (or an approximation thereto) whereby materials and service inputs in terms of base-year prices are subtracted from output also in terms of base-year prices, gives meaningful results and is the one generally followed. The series of net output in constant dollars derived in this way are so compiled that the relationship between the various primary inputs and output in each industry is kept constant (i.e., profits per unit of output, wages and salaries per unit of output, depreciation per unit of output, etc., for each industry are held fixed at base-period rates). Actually these rates are continually changing, so that a comparison between a measure of physical production and a measure of any or all factor incomes and depreciation (expressed quantitatively) would reveal changes in "productivity" over time. The most popular and, at present, practicable comparison is that between labor input and physical production whereby changes in output per man-hour are measured over a period of years. However, the direct method of summing primary inputs was followed in the derivation of the industry GDP weighting system.

FORMULA AND WEIGHTING SYSTEM

The formulae used throughout the production approach are of the base-weighted Laspeyres type, either averages of relatives or relatives

[25] See also the Alterman-Jacobs paper in this volume.
[26] See also possibility of a "difference deflator" sketched in the Phillips' paper.

of aggregates. And as for most of the major indexes, all output indexes are now compiled in terms of 1949=100. While other formulae (such as the Paasche, Marshall-Edgeworth or Fisher Ideal) possess some advantages over the Laspeyres type in certain circumstances, we have found the Laspeyres more practicable and easy to interpret when used over a reasonable period of years, and believe that we should concentrate our limited resources on developing more reliable indicators rather than devote extra time to the design and operation of more elaborate weighting systems.

Although the objective always is to measure changes in real GDP, in practice it is only possible to derive a complete measure for each industry in the base period and to project this ideal measure by means of indicators designed to approximate it as closely as possible. First GDP for each industry in the base period is expressed as a percentage to the total (weights). Then indicators of volume for each industry are constructed—index numbers with the base period equaling 100 (relatives). Finally, the relatives are combined according to their respective weights into a composite index representative of GDP in constant dollars.

The 1949 interindustry flow table made a major contribution to the industry production approach—a fifty-industry distribution of GDP at factor cost on an establishment basis. The distribution was based on the industrial breakdown of GDP at factor cost published in the national accounts after adjustment to achieve a complete establishment classification. Investment income and capital consumption allowances are hard to fit into an industry classification when the reporting unit is the multiestablishment firm whose establishments can be coded to different industries according to the nature of their principal products or types of activity. For instance, many major pulp and paper companies operate large wood-cutting establishments (forestry industry) as well as the pulp and paper mills themselves (manufacturing establishments). While salaries and wages recorded by establishment can be allocated, if necessary, to different industries, investment income and capital consumption allowances generally apply to a firm's total operations and any allocation by establishment must, of necessity, be rather arbitrary. For the input-output table, however, such adjustments were made. The 1949 method of distribution was crude, usually on the basis of value of output or salaries and wages. If data were available on services purchased by manufacturing companies (e.g., advertising, insurance, etc.), and if suitable cost accounting methods could be devised to allocate these costs between establishments of the same firm, GDP originating in each industry could be derived by deducting total intermediate input from total output. The complete interindustry flow system would therefore not be required to provide the GDP weight structure, but the availability of the complete system would help verify its accuracy. It should be noted that the above method allocates profits residually, which is the correct procedure since profits are themselves a residual.

The interindustry flow table contained adjustments to the industrial breakdown of profits to remove any unrealized gains or losses on inventories which occurred as a result of compiling inventories at book value. To be consistent with the valuation of production, inventories should be valued by multiplying the physical change by weighted average prices during the year. Such an adjustment involves assumptions about the commodity content of inventory holdings, the normal turnover period for the industry, and the accounting methods used by the firms in arriving at book value. The difference between the value of the physical change and the reported book value is known as the "inventory valuation adjustment" which has recently been incorporated in our revised national accounts.

Below the level of detail obtainable from the input-output project, 1949 industry weights are distributed according to census "value added" (value of production excluding sales and other excise taxes less materials, fuels, and electricity consumed), net margins (for trade), gross revenues, or payrolls. Within industries, commodities or services are summed on the basis of unit selling value. In those industries for which census "value added" volume indexes were computed, the effect of "value added" weights for commodities is obtained residually in that the volume of materials, fuel, and electricity is subtracted in total from the volume of output. The implicit assumption that purchased services are proportional to the gross or census "value added" valuations within industries may not be unjustified since the general processing, distribution, and marketing characteristics tend to be similar for the majority of products in an industry.

In this connection, a test was carried out whereby the manufacturing industry indexes were reweighted with census "value added." The results, compared with those using the GDP at factor cost weighting system, are shown in Table 2 for total manufacturing, durables and nondurables.

Although the results do not reflect any changes over time in the relative proportion of business services purchased within industries (relationships are fixed at the 1949 base), they do incorporate the effect on the weights of the varying proportions of these costs as between industries. The effect was negligible on the composite durable manufacturing index. Even though the component indexes showed considerable dispersion, the proportions of GDP to "value added"

TABLE 2
The Effect of GDP at Factor Cost and Census "Value Added" Weights on Production Indexes

	Total Manufacturing		*Nondurable Manufacturing*		*Durable Manufacturing*	
	GDP	Value Added	GDP	Value Added	GDP	Value Added
Weights (%)	100.0	100.0	53.915	56.960	46.085	43.040
1949	100.0	100.0	100.0	100.0	100.0	100.0
1950	106.2	106.3	106.0	106.2	106.5	106.5
1951	115.0	115.5	110.8	112.2	119.9	119.8
1952	118.5	119.0	113.2	114.8	124.8	124.5
1953	126.4	126.7	120.2	121.8	133.6	133.3
1954	122.9	124.0	121.2	123.4	124.8	124.8
1955	134.7	135.8	130.4	132.7	139.7	139.8
1956	145.1	145.8	138.1	140.0	153.3	153.5

varied little. For nondurables, however, the "value added" weights for chemicals and petroleum products (which recorded considerably larger increases in output than the composite nondurables index) were proportionately much higher than the GDP weights and accounted for most of the differences in the levels of the two series. These differences in the weights suggest that the costs of business services were particularly high in the chemicals and petroleum refining industries. No doubt such costs as advertising are relatively greater, but the difficulty of reporting proper factory product valuations (especially for refineries) was a factor. Many major oil companies operate oil wells, refineries, and distribution outlets; and their reported value of output is difficult to determine at each industry boundary thus affecting the comparability of the residual census "value added" with that of other industries.

MEASUREMENT APPROACH

As explained earlier, it is not at present possible to calculate a complete quantum measure of GDP at factor cost at the industry level, and efforts are concentrated in deriving the nearest approximation. The indicator that comes closest to measuring the desired concept is the volume of census "value added" (selling value of final products ex sales and other excise taxes plus the value of the change in goods in process less value of materials, fuel and electricity consumed) which will henceforth be referred to as "net" output for purposes of this paper. The concept can only be measured in years for which industrial census data on products, materials, and fuel and electricity are available, and then only in those industries for which the data are appropriate and sufficiently complete. As census material usually lags the current period by at least one year, the last available benchmark indexes are projected forward by means of monthly or quarterly indexes based on less complete and precise data. The annual census of industry and other surveys which provide a considerable amount of information on both outputs and inputs are fully exploited in the development of the production indexes.

To construct annual benchmark indexes for individual industries, census data on recorded quantities and values of products or materials or both are first edited for inconsistencies and then compiled in terms of base-period (in this instance 1949) constant dollars. Within each industry there generally are some products and materials for which no quantity or price information is available. Each year the current value proportion is calculated of items for which quantities are available to the total value of output. This "coverage adjustment" is then divided into the sum of the constant dollar items and has the effect of deflating the total value of output or materials with a currently weighted unit value index based on the items for which quantity and value are recorded. Used with caution, this procedure is better than one which assumes that changes in the volume of reported items represent changes in the volume of all items. The proportion of represented items is often subject to wide variations because of the introduction of new products or sharp changes in output of particular items. The "coverage adjustment" device was not used when the coverage of represented products was less than half the total value of production in any industry. A higher coverage was generally required for materials used, since materials' prices tend to diverge more than products' prices. Certain important products or materials were handled individually because their unit values diverged significantly from those of the majority of products in the same industry.

Where both the constant dollar "blown up" aggregates of products and materials were judged accurate enough for the measurement of an index of "net" output, the materials, fuel, and electricity aggregate was deducted from the products aggregate according to the following formula:

$$\frac{\Sigma\, Q_i P_o - \Sigma\, q_i p_o}{\Sigma\, Q_o P_o - \Sigma\, q_o p_o}$$

in which Q and P stand for the quantities and unit values of products (output) and q and p stand for the quantities and unit values of materials, fuel, and electricity consumed in the production process (input).

Where the data were not suitable for the measurement of real net output, alternative indicators were used, such as the volume of gross output or revenue, the volume of materials used, values of output or materials deflated with available price or "cost of production" indexes, or labor input. In each case, the objective of net output was kept in mind and wherever possible appropriate adjustments were applied. It was possible in several cases to detect discrepancies arising from changes in the amount of duplication or processing or from incorrect reporting and to apply compensating adjustments to the gross series.

Rather than project the base-period GDP valuation by means of the volume indicators, we convert the aggregates to index numbers at the three-digit industry level and apply the GDP weights at this stage. Most analysis by users is conducted at this level, and the derived weighted indexes provide a more convenient means of determining the point contribution of each industry or industry group to the overall total.

TYPES OF INDICATOR

This section describes the measurement of net output (census value added), phsyical output, value of gross output deflated, labor input, volume of materials used, and other indicators. The relative importance of each type of measure is indicated in the following table.

TYPE OF INDICATOR—REAL OUTPUT INDEXES
(Showing 1949 percentage coverage of total G.D.P.)

	Benchmark Indexes	*Quarterly or Monthly Indexes*
Census value added	31	none
Gross output	20	42
Value deflation	37	32
Labor input (adjusted for output per unit of labor input)	—	10
Labor input (unadjusted)	6	10
All other types	6	6
	100	100

Net Output Indicators. Many factors influence the level of net output. Vertical integration of the manufacturing process, which occurs more often in industries turning out highly processed goods, is an important influence. And improved machinery may permit a higher output from a given amount of raw materials.

Our experience so far indicates that the most important factor is changes in "product mix" when an industry making a variety of products shifts some of its output to goods requiring a higher or lower degree of fabrication. During the war, for instance, in the meat packing industry, the production of canned and cured meats increased greatly relative to that of fresh meats, which require less processing. As a result, the net index rose substantially more during this period than the gross index. The opposite movement occurred immediately after the war when foreign demand for canned and cured meats dropped to a more normal level. Another example is the dairy products industry, where the greater relative increase in ice-cream production and milk and cream bottling (products with proportionately higher net ratios than butter, cheese, and concentrated products) appears to account for most of the difference between the net and gross indexes over the period measured.

Not all industries, however, show a higher net output trend. Some, like the flour and feed milling industry, show an opposite movement, partly as a result of a progressively larger production of a cheaper type of flour and a relative decline in the output of better grades. In some years sharp changes in the volume of output of particular products had substantial effects on the movement of the net index.

Other factors which may have had an influence on the level of net output are the more efficient use of fuel and power or, as mentioned earlier, changes in vertical integration and in the yield of raw materials. But it is impossible now to assess how much the effect was. However, at least for industries with a high materials-products ratio, shifts in the type of products fabricated was apparently the main influence. (See Table 3 for comparison of net and gross indexes for selected industries.)

The measurement of the agriculture industry on the net basis is highly significant. A preliminary index has been developed (Table 3) which makes possible a more complete evaluation of trends in the farm economy. As expected, in years of large changes in crop size, changes in the net index were much sharper than in the gross series. Affecting the trend over the whole period, however, was the steady and rapid growth in the volume of materials used by farmers. Increasing mechanization over the past two decades and the trend towards larger farms and more scientific management of farms have resulted in sharp advances in utilization by farmers of commodities produced in outside industries. This trend has been accompanied by a steady decline in the agricultural labor force and the replacement of man power and animal power by mechanical energy.[27]

The degree of divergence between net and gross output often depends on the degree of homogeneity of the industry measured. All other things being equal, the net output index of a one-product industry will move parallel to its index of gross output. The more diversified the production of an industry, the more sensitive is the net output index to the influence of product mix. This is particularly true of industries in which materials account for a large proportion of the

[27] A similar trend was revealed in the first U.S. industry real product estimates, for farming, by Kendrick-Jones, reviewed in Phillips' paper in this volume.

TABLE 3

Indexes of Net and Gross Output for Selected Industries

(1949 = 100)[a]

	Agriculture		*Flour and Feed Mills*		*Meat Packing*		*Dairy Products*		*Breweries*		*Tobacco Products*		*Sawmills*		*Steel Mills*	
	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross
1935	88.3	73.3	53.4	48.1	54.7	59.1	41.3	54.8	24.6	28.0	31.1	39.3	54.7	55.0	27.6	28.0
1936	80.8	67.8	56.4	52.9	66.6	70.7	46.0	58.6	25.1	29.0	35.7	42.3	60.1	60.9	32.8	32.5
1937	78.5	68.1	54.4	50.1	67.5	74.3	48.3	61.1	28.6	32.6	41.4	47.7	68.8	71.2	44.9	45.0
1938	99.8	84.0	52.6	49.0	70.7	70.7	48.7	64.0	28.5	32.1	45.9	51.5	65.4	66.1	36.8	35.5
1939	115.4	96.0	57.3	56.3	81.9	76.4	50.5	65.7	28.8	32.1	49.2	55.1	69.5	69.9	43.8	41.7
1940	118.4	98.1	63.8	62.5	91.8	91.5	55.2	69.7	33.8	37.5	53.1	59.0	81.9	83.1	65.0	64.1
1941	100.6	87.0	71.9	72.7	107.9	106.7	63.9	77.9	44.1	48.0	61.3	64.1	87.2	88.7	88.0	84.7
1942	150.2	124.2	70.0	74.4	126.2	111.5	72.9	86.5	54.9	59.2	76.0	77.1	89.5	90.5	121.6	111.8
1943	101.0	94.4	87.9	91.4	141.2	124.9	77.7	90.8	48.6	52.2	82.3	81.9	78.6	79.4	117.9	106.3
1944	124.5	111.8	97.7	100.5	153.4	146.8	79.2	92.2	58.5	61.5	89.6	89.3	79.2	80.4	104.3	95.0
1945	94.2	92.5	96.3	102.4	148.4	128.3	84.2	95.3	66.5	69.4	103.2	102.2	79.3	80.8	96.7	89.1
1946	104.4	102.6	112.2	114.6	134.1	111.4	83.1	92.3	77.9	80.9	90.6	91.2	88.2	89.1	71.7	68.6
1947	97.0	99.5	111.3	124.8	119.9	99.5	87.7	96.9	90.2	91.2	93.4	94.8	101.4	102.6	93.9	92.1
1948	103.8	102.9	98.2	105.8	100.4	104.2	101.7	99.4	98.5	98.7	93.4	94.9	101.1	100.4	99.1	101.5
1949	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1950	109.7	108.1	99.1	98.7	104.3	100.3	97.8	97.9	99.6	99.5	103.4	102.1	110.1	109.8	109.4	107.2
1951	122.4	118.4	109.0	108.8	102.8	99.7	104.6	100.2	102.3	103.0	95.0	94.8	116.9	115.8	129.0	127.3
1952	137.3	131.1			122.6	118.9	103.2	104.4	116.3	115.0						
1953	126.8	123.1			119.7	116.1	111.5	110.9	122.3	120.3						
1954	92.1	97.5					120.4	115.9	120.5	118.3						

[a] These indexes incorporate two weighting systems: for 1935–46, average unit values in 1935–39 were used as weights within individual industries; after 1946 weights are based on 1949. The two sets of indexes were linked in 1946.

value of products, where even slight changes in the composition of production have a considerable effect on the net measure. Because for such industries the "net" aggregate is very sensitive to even small errors in either products or materials, the data were subjected to a careful scrutiny. Where the net index diverged markedly from the gross, and the movement could not be reasonably explained (for instance by changes in product mix or integration), the original establishment returns were examined and advice sought from DBS industry specialists. Often the data had clearly been erroneously reported and the errors missed in editing and it was possible to apply proper adjustments. Sometimes correspondence with major producers helped to correct important inconsistencies. When serious doubts as to the suitability of the data for purposes of the net indexes could not be eliminated, alternative indicators were substituted.

In an index of net output, when changes in the nature or quantity of raw materials are not reflected in the measurement of the resulting products, a problem arises similar to the problem of measuring changes in quality in the absence of sufficient detail in the tabulation of commodities or services. Changes in quality could be reflected in the volume of materials but not in the volume of output. While such changes will affect the level of the volume of materials, no compensating factor will be recorded in the measurement of the products unless an additional breakdown of commodities by types of materials used in their fabrication is available in census returns. This is often not practicable. In industries where discrepancies of this sort arose, computations of net output were not attempted.

For the revised manufacturing indexes soon to be released it was possible to develop net output indexes for industries representing 44 per cent of the 1949 weights for manufacturing. Net indexes were also compiled for electric utilities. Apart from industries covered by the Index of Industrial Production, net series are available for agriculture and, on a modified basis (deduction of fuel and major supplies only) for most components of the transportation division: railways, civil aviation, urban transport systems, interurban bus transport, and truck transportation. For railways and civil aviation the output measures consist of ton-miles and passenger-miles supplemented by the deflation of other revenues with appropriate price indexes. For railways, data are available on types of commodities transported, so a series reflecting changes in the type of freight handled could be developed. This series diverges significantly from one based on total ton-miles in periods of heavy bulk transport such as when grains or iron ore are shipped in relatively greater volume than items such as automobiles or appliances which are subject to higher tonnage charges. For truck and interurban transport, output measures are based on deflated revenues and for urban transport on number of passengers carried.

Those series for which net indicators could be calculated accounted for 31 per cent of total GDP in 1949. For purposes of comparison, they are shown in Table 4 along with the corresponding gross indexes for 1946–53.

TABLE 4

Comparison of Net and Gross Group Indexes for Selected Industries (1949=100)

	Total Selected Industries		*Agriculture*		*Manufacturing Total Selected Industries*		*Electric Utilities*		*Transportation Total Selected Industries*	
	Net	Gross	Net	Gross	Net	Gross	Net	Gross	Net	Gross
1946	94.3	93.3	104.4	102.6	85.4	84.6	78.2	78.6	95.5	95.2
1947	96.0	97.0	97.0	99.5	93.6	94.0	89.3	88.8	101.1	100.5
1948	100.6	100.6	103.8	102.9	97.9	98.7	94.2	93.9	101.2	101.1
1949	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1950	107.4	106.9	109.7	108.1	107.0	107.3	113.7	113.2	101.0	100.9
1951	117.7	115.6	122.4	118.4	114.7	114.0	131.1	129.5	109.4	108.7
1952	125.5	122.6	137.3	131.1	115.2	114.8	143.4	141.3	116.1	114.6
1953	123.7	121.7	126.8	123.1	120.2	119.7	151.0	151.0	116.3	114.5

In the manufacturing group, in which the industries represented by net indexes accounted for 12 per cent of the total GDP in 1949, the effects of deducting commodity inputs from the output aggregates are largely offsetting. Earlier, in 1940–45, however, increased demand by the armed services and foreign countries for goods requiring a higher degree of processing affected the input-output ratios of many industries with the result that, on average, the net indexes showed a somewhat greater increase than the corresponding gross series.

Because weather so affects the size of grain crops, which in Canada account for a large part of agricultural output, differences between net and gross indexes of farm production can be substantial. Consequently the indicator for agriculture (nearly 11 per cent of total GDP in 1949) should be calculated on a net basis. Unfortunately a more complete evaluation of the effects of using the value added formula is not possible at this time, but experience so far suggests that, in normal times, and barring any sharp changes in crop production, the use of gross output indicators will not, on balance, adversely affect the over-all measure of real GDP to any significant extent.

An important advantage of computing net output indicators apart from their use in industry output analysis and productivity ratios at the three-digit level is that they provide an excellent check on the adequacy of the basic data. When they are compared with indexes of labor input, materials used, and gross output, they permit a critical examination of related industrial statistics and play an important part in the improvement and integration of these basic data.

Gross Output Indicators. This type of indicator is used for industries where data on materials used are either unobtainable or not suitable for deriving net indexes. In most cases the total value of output or revenue is available from annual surveys so that the adjustment for total coverage can be applied in the calculation of the benchmark indexes. The series that can be measured by physical volume of output include the primary industries—forestry, fishing, trapping and mining, and gas and water utilities. Because materials used are not an important proportion of their total output, gross output indicators are a close approximation to net output. In manufacturing, nearly one-third of the GDP originating in this industry is represented by gross measures. In addition, shipping, stevedoring, pipelines, toll bridges, tunnels and ferries, grain elevators, telephone, telegraph and cable, motion picture theatres, education, hospitals, and undertaking can be represented by series indicative of physical volume of services performed. All of these series accounted for about 20 per cent of the total product in 1949 so that more than half of GDP can be measured directly with physical volume of output data (net and gross).

Value of Output Deflated. Deflation by either appropriate existing price indexes or derived cost of production indexes yields this type of measure. As will be explained below, series obtained by the second method can have serious limitations. Price deflation was used for the following series: manufacture of heavy electrical equipment, taxi service, storage and warehousing, postal services, wholesale trade, repair establishments, retail trade (value of sales by store-types are individually deflated with corresponding retail price indexes and weighted with net retail mark-ups in the base period), insurance other than life, real estate (including residential rents), stock and bond dealers, health services other than hospitals, barbering and hairdressing, dyeing and cleaning, hotels and lodging houses and restaurants, and cafes and taverns. These series accounted for about 27 per cent of GDP in 1949. Deflation by cost of production indexes was used for construction and for manufacturing industries representing 15 per cent of manufacturing GDP, about 10 per cent of total GDP in 1949.

Labor Input. Man-hours or deflated payrolls were used as output indicators for a few manufacturing industries, radio and television communication, government services, and armed forces and domestic service, about 6 per cent of GDP in 1949.

Volume of Materials Used. This type of indicator is used in manufacturing industries which accounted for 2.5 per cent of GDP in 1949.

Other Indicators. For the remaining 3 or 4 per cent of GDP consisting of life insurance, banks and other financial institutions, stock exchanges, religious and welfare services, business services, and miscellaneous personal services, indicators are designed to represent the desired concept of service as closely as available data will permit. Sometimes only population figures are obtainable. For life insurance and financial institutions, the measurement approach has not yet been completely explored, but the concept of service rendered suggests certain relevant indicators; in the meantime employment data are used.

PRESENT STAGE OF DEVELOPMENT AND FUTURE PLANS

Now that the revision of the Index of Industrial Production is completed, efforts will be concentrated on the further development of the production measures for the other industries in the economy. Most of the developmental work is already completed for the commodity industries and for the transportation, public utilities, trade, and government divisions. Research is still required in the other services and finance areas. Some of the new benchmark indexes for the commodity industries and for the public utilities, transportation, trade, and government divisions, appear in the tables shown earlier. But these have not yet been incorporated in our experimental total real output series. Although the total series is used only for internal purposes at present, it is shown beside the deflated expenditure series in the last section of this paper.

This experimental series is compiled quarterly for purposes of current analysis, and the data used in its calculation are necessarily more crude than annual data. Employment data are used more extensively in the current series, especially in the manufacturing division. In the revised manufacturing monthly indexes, however, adjustments for changes in output per man-hour have been projected from past trends based on the benchmark series for those industries represented by man-hours in the monthly series. These adjusted series should more closely approximate the benchmark levels than they have in the past. Eventually we expect to publish the quarterly production series along with the deflated expenditure estimates already contained in the current national accounts bulletins.

Since most of the data available to measure production by industry on a quarterly basis are already available by months, we intend to experiment with a monthly measurement of total nonagricultural production. Such a series would be extremely useful for detecting trends and turning points in advance of the quarterly national accounts. The monthly Index of Industrial Production is valuable in this connection, but it is more sensitive to short-term influences than the more comprehensive and stable GDP. Moreover, the seasonal adjustment of the current series can be carried out more accurately and conveniently on a monthly basis than by quarters. There are, admittedly, many additional problems of data and timeliness, but in view of the usefulness for current economic analysis of such a monthly series, we think the effort is well worth while.

Deflation of Final Expenditure Categories

The object of the deflation process is to revalue each of the quanities currently produced in the prices of the base period, preferably by associating a price relative with the value of each individual commodity or service appearing as final product. Given the limitations of available data, one must select or construct price indexes which will approximately describe the price movements implicit in the value series. For some expenditure groups a large amount of detailed price information is available, but it must be used in a combined index because there is no corresponding breakdown within the value data (e.g., personal expenditure on food, at intervals between consumer sample survey benchmarks). For other series final product price information is lacking, although the value detail may be more or less refined, and deflators to approximate the product price movements must be constructed from data on the cost of labor and material inputs into the product (e.g., nonresidential construction).

It is desirable that the deflated estimates of GNE approximate a base-weighted or Laspeyres volume index, to match the measures of industrial real output. Such a volume index will result if the value series is deflated by a currently weighted or Paasche type of price index. To approximate the price index the value series are usually deflated at a fine level of detail, within the limitations of price and value data. Occasionally a currently weighted price index is specially constructed for deflating, as for exports and imports. The currently weighted subgroup price deflators which emerge from the process of summing both current and constant dollar items and dividing one into the other are known as implicit price indexes. They are only currently weighted to the extent that they incorporate the changing current item weights. If an item is composite, however, like food, the deflators cannot be currently weighted.

A description of deflation procedures was published recently in conection with the historical revision of the national accounts.[28]

REFINEMENTS FOR USE IN CURRENT ANALYSIS

The development of seasonally adjusted quarterly constant dollar data has been given a high priority in Canada as well as in the United States.[29] These data are necessary if cyclical changes are to be interpreted in terms of physical volume and price changes, but the price and volume estimates required must be highly accurate. Some loss of accuracy can occur when the base period is remote in time, and a more recent time and weight base will provide a better answer for purposes of short-term analysis.

In general the weight base should be altered wherever there has been a substantial change in economic conditions. For current volume estimates these changes will appear as a significant dispersion of the prices which constitute weights in the volume index. For long-term comparisons, a period such as 1926–58 should perhaps be broken into time segments, each deflated with its own time and weight base, then linked and published either in constant dollars or as index numbers. We have published a long series on a 1949 time base, but the components were the 1935–39 based series from 1926–47, and the 1949 based series, from 1947–58, both linked at 1947. The industrial output index followed a similar procedure.

The single published series cannot satisfy requirements of all users. Periodic rebasing will partially satisfy the requirements of current economic analysis.[30] If rebasing is done following significant changes in price structure, the weights will be sufficiently representative of the current period, and the results will adequately approximate those that would be obtained if the deflators were continuously rebased to the period immediately preceding the current period.

Certain tests have been made recently of this procedure. A Laspeyres type price index of GDP, with a time and weight base of 1955, was constructed. It was used at its aggregate level to deflate the seasonally adjusted value series in order to derive a rough estimate of

[28] *National Accounts, 1926–1956, op. cit.*, pp. 176–85. (A similar statement appears in the U.S. National Income Supplement, 1954.) For more detail see *Problems and Techniques of Measuring the Volume of National Output* by George Jaszi and John W. Kendrick (Inter-American Seminar on National Income, Santiago, Chile, 1953).

[29] "The National Economic Accounts of the United States," Hearings of the Subcommittee on Economic Statistics of the Joint Economic Committee, Washington, 1957, p. 161.

Quarterly seasonally adjusted constant-dollar final products were published in the *Survey of Current Business*, U.S. Department of Commerce, December 1958, p. 10.

[30] If rebasing were to make a substantial difference in results, there would be a case for altering the base of the volume measurements also.

the volume changes from quarter to quarter. For the second and third quarters of 1957 additional comparisons were made, involving the rebasing of deflators to the base of the preceding quarter equal to 100. The rebased deflators were then used to construct both a Paasche (currently weighted) and a Laspeyres (fixed weight) index (both with the seasonally adjusted quarterly values used as weights). The results for the second quarter of 1957 were as follows:

	Estimated Price Change from the Preceding Quarter GDP excluding inventories
Laspeyres (1955=100)	+0.69 per cent
Laspeyres (1st Qtr., 1957=100)	+0.76 per cent
Paasche (1st Qtr., 1957=100)	+0.74 per cent

The results indicated that current rebasing was not required; use of a fairly recent base, 1955, was adequate.

Seasonal Adjustments. Seasonal adjustment of deflated quarterly expenditures can be carried through by dividing seasonally adjusted values by seasonally adjusted prices or by direct seasonal adjustment of constant dollar quarterly expenditures. The former method takes less resources, since not many prices have to be seasonally adjusted and the values are already adjusted in their own right. Direct seasonal adjustment is onerous, since many quantity series have to be adjusted directly. We are trying it both ways for one period only, 1947–57, and will perhaps discover that the simpler method can be used henceforth.

Problems of Measurement

CHANGES IN QUALITY

Most production measures fail to reflect intrinsic changes in quality. A 1958 television set, for instance, has a sharper picture, more automatic features, and is generally a more efficient instrument than its 1948 counterpart. To the extent that quality has improved, the output series will have a downward bias, since there appears to be no satisfactory statistical procedure to reflect intrinsic changes in quality. The only consoling fact is that there probably are often some offsetting features, such as less durability.

The use of price deflation, as in the Canadian expenditure approach, can sometimes take account of quality changes. In the compilation of retail price indexes, for instance, efforts are made to reflect measurable changes, as in the thread count in men's shirts or the number of shelves in a refrigerator. These efforts, however, are limited to differences in visible specifications and cannot extend to gradual, long-term changes in the efficiency, design, comfort, or durability of the great mass of consumer and investment goods produced by a highly industrialized economy.

A closely allied problem is caused by the lack of sufficient detail in many commodity and service classifications where data are often collected in statistical classes such as men's dress shirts, railway passenger-miles, etc. No problem would exist if it could be assumed that the relative proportions, within such classes of goods, of different types and qualities remained constant over the period covered by the series. However, consumers' tastes and living standards change, and producers are governed accordingly. If, for instance, the proportion of expensive shirts has risen, then the quality of the class "men's dress shirts" may be said to have improved, but the production series based on the total number of men's dress shirts would not reflect this change. However, the value series can be deflated by an appropriate price index. Changes in specifications are reflected in value totals. If the value total is deflated by a price index based on the more popular specifications of the item in question, the resulting aggregate will reveal the true change in physical output, assuming that the prices of all the different types of the product move in the same way as those represented in the price index. This assumption is recognized to be more valid than that of the constant composition of commodity classes.

The problem of using price deflators in the industry approach is to obtain price indexes corresponding to the various industry valuation levels and based on sufficient detail. Most existing price indexes are based on prices at the primary production and final distribution levels and often do not include either the intermediate or the more complex final products of industry. Particularly in secondary manufacturing, existing deflators are often not suitable for deflating the detailed industry values that form the basis of the industry approach. Most physical output measures in this area are therefore based on available commodity production detail. In the primary industries, commodities, in general, are more amenable to quantitative measurement so that the problem of handling variations in "group" quality is less likely to occur. Another problem is that the industry classification system may subdivide what is, in practice, a continuous integrated operation into two or more separate industries. This makes it difficult to obtain market valuations of output for the separate classifications and in these cases, the commodity approach is more practicable.

The development by the Prices Division of the DBS of special manufacturers' price indexes, based on a wide range of products cross-classified according to the Standard Industrial Classification, will soon be completed. These series will provide much more suitable price information for use in conjunction with industrial values of production and a more extensive use of the deflation method in the measurement of manufacturing production will then be possible.

SHORTCOMINGS FOR PRODUCTIVITY ANALYSIS

In the absence of proper physical output data or deflators in some areas neither approach takes account of changes in productivity. In the production approach, proper quantity or price data were not available for certain industries in which output and prices are difficult to determine in unit terms, a problem characteristic of industries producing investment goods such as industrial machinery, railway rolling stock, aircraft, shipbuilding, and building construction where output is more of the custom type and generally not organized on a mass production basis. The same problem is encountered in the expenditure approach where the same items appear as components of gross fixed capital formation or of government expenditure on goods.

This lack of price and quantity series for finished products has made it necessary to rely on a cost approach for deflating current dollar figures. The usual procedure is to construct a deflator based on prices of the major materials used and on average hourly earnings for each industry or expenditure component. This approach assumes that prices of the finished product will move in the same way as a weighted average of material prices and wage costs, and no adjustments are made for the effects of productivity changes on unit labor costs or for changes in profit margins and overhead.

Prices of raw materials are generally believed to change earlier and fluctuate more widely than prices of finished products, partly because wage costs are relatively rigid but also because profits and overhead per unit of output vary. Industries where there is some degree of monopoly tend to keep prices fairly rigid whether demand and production are falling or rising. However, when demand is rising and operations are at capacity, prices may move fairly well in line with costs. This probably means that in such industries between periods of general recession and expansion a price index based solely on wage and material costs will fluctuate more widely than the true price index of finished products. However, insofar as competitive conditions prevail in some sections of the industries or that escalator clauses are included in long-term contracts, the time sequence of price changes for materials, wages, and finished products will be more in line. The development of new price indexes for manufactured products noted above will improve the deflation of machinery and equipment items. Further research is required to develop more satisfactory deflators for nonresidential building construction. Both approaches, however, follow the same general procedure, and although the technique is questionable it is at least consistent.

MEASUREMENT IN NONMARKET AREAS

The two approaches are aimed at arriving independently at the same global measure of real GDP. Therefore, the same basic guiding principles must be common to both. The production boundary, the point across which all goods and services are measured as they pass from the production process to final disappearance, must be clearly determined and measurement should neither fall short of, nor extend beyond, this boundary. Moreover, definitions of output in both approaches must be mutually consistent, i.e., the concept of output implied by the indicator selected in the production approach should be the same as that used in the expenditure approach.

Usually these principles are not difficult to follow, and definitions and procedures are quite clear. Where a market transaction takes place between a buyer and a seller a good or service (or bundle of goods and services) is exchanged for money or claims on money. Thus each value is implicitly composed of a physical good or a service at some market price defined as the average unit value of the item involved in the transaction. The nature of the commodity or service involved is quite clear, though data may not always be available to measure the transaction in the ideal way. Where no clear market transaction takes place, as in the case of government services, the quantity of output may be difficult to determine.

For most government departments, concerned mainly with administration and defence, measurement of output is, at present, impractical. Much effort and expense would be involved in attempting to devise proper indicators, although some acceptable measures immediately come to mind such as the number of unemployment insurance claims handled or the number of income tax returns processed. Such statistics would be readily available, however, for only a few departments and agencies, and at present we treat all public administration and defence services on the physical cost basis in the interests of uniform treatment in this sector. Although productivity is assumed to be constant, the implications of this procedure are considered less damaging for purposes of general economic analysis than any attempt to measure or arbitrarily estimate changes in real output in nonmarket sectors largely devoid of appropriate data.

The current official expenditure estimates use the cost approach for the measurement of school and hospital services, while the experimental production estimates follow the output concept. Those responsible for the deflation of the expenditure estimates would like to keep the national accounts valuation and deflation system intact for purposes of price and quantity breakdowns of existing concepts and have been reluctant to accept the output measurement. At the present time the problem of consistency in this area is under discussion. Ultimately, however, the main objective must be to achieve consistency between the two approaches.

INTERMEDIATE SERVICE COSTS AND "AREA DIFFERENTIATION" OF PRODUCTS

Theoretically, in the measurement of industry net output, the volume of purchased business costs, along with materials, fuel, and electricity, should be deducted from gross physical output. While Canadian annual census surveys provide sufficient data on materials, fuel, and electricity for a considerable number of industries, no statistics are at present collected, by industry, on purchases of business services such as advertising, insurance, transportation, and communications. Therefore, it is not possible to carry the calculation of real value added down to gross domestic product originating, and the resulting indicators still contain the duplicating effect of these service costs which are counted elsewhere as the output of the service industries concerned. To the extent, for instance, that the use of these services has increased proportional to "census" value added (gross output less materials, fuel, and electricity) the derived indicators of net output will show an upward bias. The possibility is being explored, however, of deducting these business services in total from the all-industry aggregate. The advisability of doing this would depend on how much effect any relative increases or decreases in these costs have on the indicators. This problem can best be illustrated by an example.

Suppose that there is a Canadian population shift from the central regions to the west coast and that there is a corresponding shift in the regional pattern of automobile sales. The retail price of cars is considerably higher in Vancouver than it is in Toronto which is close to the point of production, mainly as the result of the difference in the cost of transport. Let us assume that all other elements in the situation remain the same but the value of total retail sales rises simply because of the increase in transportation costs.

If the current value of sales is deflated by a retail price index of passenger cars, the result would be larger quantum even though there has been in fact no change in the total number of cars sold in both periods. Thus the result obtained by deflating the value of sales differs from the measure derived from the total quantity of sales. To get identical results, in this case, the total quantity of sales approach would have to differentiate between cars sold in different areas; they would have to be treated as different products, with the numbers sold in each area weighted by their respective unit values in the base period.

If, in the production approach, the total quantity of sales had been used as the projector of base-period gross revenues of automobile retail dealers, and the physical cost of supplies and services subtracted from this figure to derive constant dollar net output, the deduction of the higher total outlay for transportation charges in the current period would result in a relative decline in net output of automobile retailers. This would nullify the corresponding increase of production in the transportation industry and be inconsistent with the deflation of final sales. In this case it would be preferable not to deduct the transportation input of car dealers and allow the increase in transportation output generated by Vancouver car buyers to be reflected in the real output of the transportation industry.

Thus, when the effect of changes in the input of services can be clearly appraised and measured at the final products stage (in other words, when the value of the service content of goods can be distinguished, and the consumer is, in effect, purchasing a separate service), the effect must be incorporated in the measure of the quantity of production before the deduction of commodity and service inputs in the same way that any changes in the physical input of commodity materials (affecting size and quality of a manufactured article) must be reflected in the output measure before deriving the residual net output aggregate. In the example, the deflation method will give the correct gross figure allowing net output of car dealers to remain relatively unchanged after the deduction of the higher transportation input, and the increase in total output will be reflected in the transportation industry.

Because of differences in development costs, proximity of markets, and available supplies, both the production and distribution price of natural gas is much higher in Ontario than in the Prairie Provinces. Although the products extracted in both regions are intrinsically the same, their relative importance on a value basis is quite different, and, consequently, they were treated as separate commodities. Otherwise, the rapid relative increase in Prairie gas production and distribution in recent years would have resulted in a substantial upward bias in the production indexes.

INSURANCE

The measurement of insurance requires special treatment. In the expenditure account the cost of all types of insurance purchased by persons (except fire and other insurance on immovable property which is bought by persons in their capacity as landlords, not as consumers, and is therefore treated as business expenditure) cannot be measured by simply taking the payments (premiums) for such insurance as equal to the price of the service, since the premiums include moneys to be disbursed (claims) either in the same year or in future years to claimants. A portion of premiums and claims constitutes merely a redistribution of income within the personal sector, so premiums and claims are ignored. The cost of the service of the institutions which facilitate this process of redistribution is measured by their administrative expenses (including profits), i.e., premiums minus claims. At the present time both real output approaches use deflated administrative expenses.

Life insurance companies and fraternal societies have an additional characteristic. They not only protect, but also invest for their policyholders. The administrative expenses of life insurance companies include their investment expenses, i.e., a "fee" which policyholders pay as part of their premiums for the management of their investments. The real-output measures should reflect these two types of service provided to purchasers of life insurance. To represent the protection service, life insurance in force could be deflated with a general price index. The investment service could be represented by funds held by the companies on behalf of policyholders likewise deflated. However, this approach has not yet been incorporated in the real output series since we feel that further study of the functions of insurance companies and of methods of measuring these functions is necessary.

RENTS

In the national accounts' industrial distribution, nonresidential net rents are treated as operating revenue and shown as income originating in the industry which owns the property, thus reflecting the actual institutional arrangements in the economy. Capital consumption allowances are included in the industry using the property. Another viewpoint is that renting is merely an alternative way of securing the use of capital equipment and that all returns to such capital equipment should be shown as GDP originating in the industry in which the equipment is used. This is the treatment used for interest and dividends. For rents, however, data problems associated with the industrial allocation of renting expenses make it difficult to adopt this treatment. In the interindustry flow table, in order to keep industrial output free of investment income, nonresidential rents were set up as a "dummy" industry within the real estate division which would receive all rents and purchase all inputs associated with the rental of buildings. For example, if a chemical manufacturer invests in a building and in turn rents it to a department store, the net rental income plus depreciation is allocated not to the chemical industry but to the real estate industry. In the real output approach the statistical convenience of the "dummy" industry device was adopted for all paid rents.

The operation of owner-occupied residential dwellings was treated in a similar manner. Owner-occupants are considered for national accounts purposes to be operating a business enterprise and are treated as landlords who rent houses to themselves as consumers. Imputed net rents plus capital consumption allowances on residential property are thus shown as a "dummy" component of the real estate industry.

A rent is also imputed on government-owned buildings used by the government. Here again the governments are considered as landlords renting to themselves. In this case, however, the imputed rents (net rents plus capital consumption allowances) can be treated as a factor of production along with salaries and wages and included as product originating in the public administration and defence industry. An alternative, of course, would be to handle this government renting activity as an additional "dummy" component in the real estate industry. The estimate of rent on government buildings is a recent replacement in the Canadian accounts for interest on the public debt used to finance productive assets and its treatment for purposes of industrial output is still undecided.

BANKS AND OTHER FINANCIAL INSTITUTIONS

The procedure by which industries are not shown as receiving interest means that the measure of output of financial institutions excludes the receipt of interest. The output of banks and similar institutions is measured by their income, other than interest, from the services they provide. Part of this service is measured by the charges made for bank services (cashing checks, issuing money orders, buying and selling foreign exchange, etc.). Part of the services to depositors, however, is paid for by the depositor allowing the use of capital without interest or at a lower rate of interest. Accordingly, imputations are made in the national accounts to represent the value of these services provided to persons and to governments; otherwise product originating in the banking industry would be negative or too low. Since no imputation is made in the national accounts for services provided to other industries, profits of other industries are overstated and banking output is understated to that extent. For real output purposes, the industry weights incorporate estimated adjustments to offset these biases. For measuring service to depositors in real terms, deposits deflated with a general price index appears to be an appropriate indicator.

Appraisal of Results

When two measures should theoretically give identical results but, in practice, give different results, it becomes important to determine which of the two measures is the more reliable. One cannot assess the reliability of the two measures of real output in mathematical terms. The best that can be done is to make a qualitative appraisal of their accuracy. Until developmental work on the production measures has been completed, however, such an appraisal would be inconclusive. As noted earlier, while the real expenditure estimates are published regularly in the national accounts quarterly bulletins, the industry production series are still preliminary and require further research and development work before they can be released for general use.

The results achieved so far are given below in Tables 5 and 6. Table 5 presents the annual results of the deflation of GDE and of the industry approach to the measurement of GDP, both at market prices, for 1949–56. The production measures incorporate the latest revised series for the industries covered by the Index of Industrial Production, and the expenditure estimates are the latest amended annual figures based on the series published in the recently revised national accounts reference document.[31]

TABLE 5

Annual Estimates of Real Gross Domestic Product at Market Prices (1949 = 100)

	Production Approach	Expenditure Approach
1949	100.0	100.0
1950	106.4	107.2
1951	113.4	113.1
1952	120.0	121.6
1953	124.9	126.2
1954	123.4	122.7
1955	134.9	133.3
1956	146.2	144.9
1957	145.5	144.9
1958	146.4	145.9

Table 6 presents the quarterly results for 1953–58 as percentage changes between each quarter and the corresponding quarter of the preceding year. In this table, the expenditure estimates are at market prices while the production series are at factor cost.

[31] *National Accounts, Income and Expenditure, 1926–1956, op. cit.*

TABLE 6

Quarterly Real Gross Domestic Product,
Percentage Changes from Same Quarter of Preceding Year

		Production Approach at Factor Cost	Expenditure Approach at Market Prices
1953	1	+5.9	+7.5
	2	+6.8	+5.9
	3	+2.7	+1.1
	4	+0.2	+1.7
1954	1	+0.2	—
	2	−0.2	−1.2
	3	−8.2	−9.4
	4	+4.4	+2.1
1955	1	+4.7	+3.9
	2	+9.5	+7.8
	3	+14.4	+13.3
	4	+7.8	+8.1
1956	1	+9.3	+10.4
	2	+7.8	+6.7
	3	+9.3	+8.5
	4	+7.5	+9.6
1957	1	+4.9	+3.9
	2	+1.4	+2.4
	3	−4.8	−4.0
	4	−3.6	−0.9
1958	1	−1.7	−2.4
	2	−0.5	−0.6
	3	+0.1	+1.8
	4	+4.5	+3.6

The fairly close agreement between the two series suggests that an average of the results may be nearer to the actual level than either of the estimates. As noted above, however, until our appraisal of the two estimates is completed, any conclusion would be highly tentative.

The two approaches are largely independent. In fact, industries in the production approach which are represented by the same indicators used in the expenditure approach account for only about 20 per cent of GDP and consist mostly of government and defense services, construction, paid and imputed rents, and some recreational and personal services. The production series are therefore useful not only as an independent check on the deflated expenditure estimates but also in focusing attention at times on the underlying value figures. Occasionally an important difference occurs between the two real output series. This calls for a re-examination of the basic data especially in those areas where the estimates are relatively weak and where compensating adjustments would more likely be needed.

A complete reconciliation of the two approaches is, at present, impossible. Ideally the deflation of final products should be carried out at such a fine level of detail that all individually specified commodities and services could be identified as the final products of particular industries, subject only to the addition of distributive margins. Countries in which the consumer goods expenditure estimates are built up on a commodity flow basis, by adding transport and distributive margins to factory shipments of individual commodities, are fortunate in having developed this method, for it lends itself to the integration of industry and final product estimates. The Canadian estimates of consumer goods expenditure are based on retail sales, which do not provide commodity detail at other than decennial census benchmarks. Currently we have only the store-type totals. We have quarterly commodity flow estimates of machinery and equipment and of course the export and import figures contain a wealth of commodity detail, but in general the possibilities of easy integration are quickly exhausted.

In practice, we find ourselves confronted with two completely different classification schemes: on the one hand the industrial classification of establishments and on the other the sectors consuming final products, namely consumers, government, business on capital account and rest-of-world. These two separate classification schemes come together only at the total level and only occasionally do the two measures of output use the same indicators. In these circumstances, we are far short of the ideal set of data as portrayed by the commodity flow worksheets underlying the input-output table. To do an input-output table each year or quarter is, of course, quite beyond our resources even if the data were all available. All that can be entered here is a plea for the extension of work on commodity flow estimates entering the current final product totals. One suggestion already made is that the next input-output table should provide extra rows for important commodity details. What we really need is to develop a new table (e.g., for 1961 in constant 1949 dollars) and to pay attention, during its construction, to the selection of a set of the more important commodity flows.

We have already attempted consistency checks in a limited number of categories. In general, these checks involved cross-classifying final products by industry in some cases, while the opposite classification of industrial products by final expenditure components was done in others. The methods used were necessarily crude and the actual results obtained were relatively inconclusive; they indicate, however, that further comparisons of the two series could prove very fruitful. For example, a detailed study of the automobile industry pointed up apparent inconsistencies in both current and deflated estimates of expenditures on automobiles, and indicated that commodity flow data are needed for the detail of consumer expenditure. Before starting these comparisons, we felt that such factors as trade margins and quality changes, which are extremely difficult to measure and trace through the two sets of estimates, might prevent any useful results being obtained. Our present feeling is that, although these may be important over time, most year-to-year discrepancies are caused by factors which can be isolated and measured—e.g., errors in prices, quantities, or values. In particular, if the comparisons are made on a current basis, with a knowledge of events fresh in mind, the task is much simpler.

COMMENT

MILTON MOSS, Board of Governors of the Federal Reserve System

It is clear from the paper by Berlinguette and Leacy that a very large and progressive effort on national accounting and related research is being undertaken in Canada. In their Division at the Dominion Bureau of Statistics (aptly named "Research and Development Division") the work done and in active preparation is considerable. More progress has been made in Canada than in most other countries in the estimation of total value of product—now amounting in Canada to a little over $30 billion. This progress is particularly evident in the estimation of total product in "real" terms. Canada was already in the forefront among countries developing their own factual record of economic growth with a regular quarterly publication of constant price estimates of Gross National Expenditures. With the announcement in the Berlinguette and Leacy paper that they are actively preparing to publish their estimates of real product classified by industry of origin on a quarterly basis, Canada's place among the leaders has been further advanced.

Certain aspects of the work in Canada on real output measurement suggest some implications for work in this area in the United States.

Canadian Program

The unique feature of Canadian national accounting work presented by Berlinguette and Leacy is the development of measures of value added in constant prices for all of the industry sectors of the economy. This has involved, essentially, expanding the scope of their index of industrial production to include output of sectors in addition to mining, manufacturing, and electricity and gas, namely, agriculture, construction, trade, transportation, real estate and other services, and government enterprises.

Two aspects of this work are especially advanced: (1) the development of annual net output indexes (deflated output minus deflated input) for agriculture, electric utilities, nearly half of manufacturing, and to some extent for transportation, and (2) refinement of value added weights for manufacturing—that is, adjustment of Census value added data to exclude services purchased by manufacturing establishments from other establishments.

Coupled with this progressive effort has been a highly commendable flexibility of approach, particularly in connection with use of net output measures—i.e., using them only with considerable caution and only where differences between net and gross measures could be adequately explained. This flexibility is also evident in the recognition that for price analysis the implicit deflators in the net product estimates have shortcomings and that independent price indexes (with base year quantity weights) are also needed for price analysis.

With so large an effort in Canada, and strong emphasis on incorporating the newest concepts in their work, certain practical details may have been given less priority over the years. Thus, at the time of this writing, serious downward biases still exist in those areas of the production index based on employment data unadjusted for productivity change—biases which will be corrected in the forthcoming revision of their indexes. In addition, a prewar base is still being used in their presently published indexes. This also is to be corrected and the year 1949 incorporated as the base year in the revision. A final note on an important practical shortcoming is the rather late release of the Canadian production index involving a lag of over six weeks following the month covered. Maintaining a balance between implementing new concepts on the one hand and taking care of practical details on the other is a difficult task.

Brief View of Results

This paper presents little in the way of final results, and is chiefly concerned with describing the various problems faced in developing more or less consistent totals of real product by two approaches. Berlinguette and Leacy discuss such problems very well—particularly in pinning down the quantitative effect of use of market prices versus factor costs and net output versus gross output indexes.

Until the more complete over-all results appear, however, my discussion can deal with only a few fragments presented in the paper.

Two sets of annual indexes—one based on the expenditure approach, the other on the production approach—are shown in the paper for the 1949–56 period. They are shown as indexes in constant prices of the year 1949. The two measures should give conceptually the same results. Indeed, with complete information on the quantity and value of the flow of goods and services, they need not be considered as two separate approaches. But, as should be expected, the estimates differ for statistical reasons.

The increase in Canadian real output for the seven-year period, as measured by the two approaches, is about 45 per cent, or approximately 5 per cent per year. As the accompanying chart shows, the production measure indicates more growth over the whole period than the expenditure measure. For the earlier part of the period shown the expenditure approach yields the faster rise. But subsequently the production figures rise much faster. From 1952 to 1956 the production figures rise nearly 22 per cent compared with 18 per cent for the expenditure figures. Fluctuations in rate of growth are more evident in the expenditure measure and in the first postwar recession in Canada—in 1953–54—the expenditure measure shows the sharper decline.

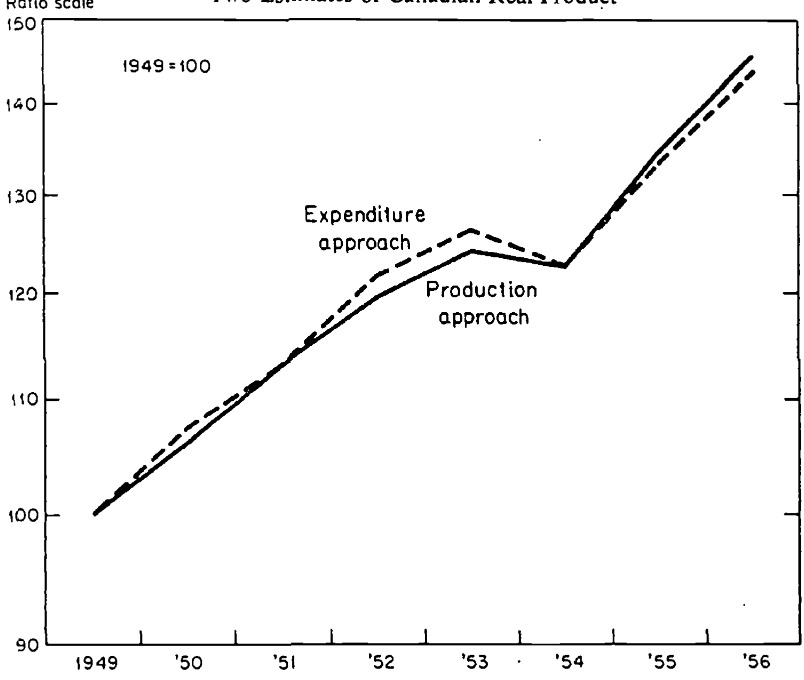
Not enough information is provided in the paper to determine the basis for the differences indicated in the period. Perhaps the presentation of more detailed results upon publication of the quarterly figures will provide clues as to why the production figures tend to show larger growth and the expenditure figures more fluctuations during the 1949–56 period.

Implications for Real Output Measurement in the United States

Regularly published official measures of real output are widely diffused in the United States. The Federal Reserve monthly index of industrial production covering manufacturing and mining represents the longest effort in regular publication of a measure of real output for the United States. In its present general form it was introduced in 1927. Beginning in 1956 a monthly index of electric and gas utilities was published and in 1959 was incorporated into the production index. The Department of Commerce since 1951 has regularly published measures of constant dollar GNP on an annual basis, and since 1958 on a quarterly basis. The Department of Agriculture began publication in 1945 of an annual measure of total real farm output. In 1956 the Bureau of Mines published an annual index of mineral production carrying forward work begun much earlier. The Bureau of Labor Statistics has developed annual measures for various sectors of the economy in connection with its productivity work, notably net output measures for manufacturing. Estimates presented for this conference by Alterman and Jacobs reflect in good part the work of the Bureau of Labor Statistics in experimenting with real output measures by industry of origin for the total economy. Measures compiled by private and public agencies, apart from regular publication, have been available for various industry sectors for a long time.

In examining Canada's joint publication of an industry of origin measure (production approach) as well as a GNP type measure

CHART 1
Two Estimates of Canadian Real Product



NOTE: Based on indexes given by Berlinguette and Leacy in this volume

(expenditure approach), it seems useful to me to reflect on the objectives to be served by these two measures, both for short-run and long-run analysis. This reflection should provide perspective on the work ahead in the United States.

Ideally the industry of origin approach provides data for analyzing supply problems and also problems of industrial performance. Ideally the expenditure figures would provide a framework for the analysis of changes in demand. I emphasize the word "ideally" because under the present conditions of data availability the production figures and the expenditure figures may be used in ways that are somewhat different from those for which they are uniquely designed to serve. Thus, for example, the production figures tend to be more detailed than the expenditure figures. As a result, they often give better indications of changes in demand in commodity markets than do the less detailed expenditure figures. The production figures tend to be more prompt and more frequent. It is no accident, therefore, that the analysis of the economy's cyclical position tends to be centered around such indicators as the index of industrial production.

A chief advantage of the industry of origin approach is that it permits analysis of productivity developments in more depth than is provided by the expenditure figures. When matched with various resource use categories such as manpower, electric power, or fuel, the expenditure figures can be analyzed only in very broad terms. In the industry of origin approach, however, the comparison can be as detailed as the industry figures permit.

The wealth of data on quantities and values of product available from the production side of the economy is worth emphasis. Compare, for example, the detail available in the United States Census of Manufactures with the Census of Retail Trade. In the 1954 Census of Manufactures, for example, data are available on quantities and values for some 7,000 products. In the Census of Retail Trade for the same year, although seventy-five different kinds of stores are shown, no data on quantity and value are available for any single product.

An interesting consequence of the availability of product detail for the manufacturing sector is its use in the United States, through commodity flow procedures, in providing benchmark estimates of final sales of finished goods for the GNP expenditure figures.

In the industry of origin *concept*, the product detail so unique to industry statistics may be lost. This is because in the net output approach the deflation of outputs minus the deflation of inputs gives rise to a total net value for an industry. No similar subtraction can be made for individual products. Perhaps it would be helpful if the national accounts provided gross product listings even though the gross measures for products may not add to the net output for industries. With appropriate assumptions about input-output relations and value-added weights for products the product detail could probably be shown together with the net output measures for industries.

Product detail of course needn't be lost. It disappears only if the net output approach is strictly followed. In short-run measures, such as the quarterly figures proposed by Canada, gross output measures combined with value added weights are used. But they are used as a compromise device until such time as it becomes possible to develop net output measures. Similarly, in the annual estimates prepared by Alterman and Jacobs, gross output measures were unavoidable for the later years shown.

The industry of origin approach—as a net output concept—is useful for long-run rather than short-run analysis. This is true at least under present conditions of data availability. Changes in the industrial composition of the total economy, which this approach can reveal so usefully, come about slowly. Changes in relations between output and usage of materials, fuel, electric power, and capital occur in ways that cannot yet be measured monthly or quarterly. Changes in the relation between input and output prices—in margins—may be more volatile than is sometimes thought. But the painstaking effort required for measuring these changes for all industry sectors of the economy is a long-run or benchmark type affair. Short-run changes in output per man-hour are measurable, if at all, only in the commodity producing sectors of the economy, notably manufacturing.

A final point on the relation between the expenditure and production approach: i.e., the need to show consistent results below the total level for at least three important areas of activity. These three areas, retail trade, equipment production, and construction are essentially common to both approaches. Retail trade figures are used in the expenditure approach for measuring changes in personal consumption expenditures and in the industry of origin approach for measuring changes in the gross output of the retail trade industry. In the case of equipment, including defense equipment, the production figures should be very similar to the expenditure figures, after adjustments for imports and exports, because for most large equipment items inventory changes in the finished product tend to be small. In the case of construction the industry and expenditure concepts may differ because of force account work but if the industry of origin approach is flexible enough to show this separately, the expenditure and industry figures should be essentially the same.

Now, these three areas are major gaps in our data needs for current analysis. When they are adequately taken care of the industry of origin and expenditure approaches will be far more useful for current analysis in the United States. Perplexities in other areas, namely, services, households, and government enterprises will probably continue to be unsolved and will be useful as challenges to graduate students and other philosophers.

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The paper by Berlinguette and Leacy on the Canadian output measures and the paper which Mrs. Jacobs and I prepared on the

United States sector output measures both indicate that one of the main uses of such estimates is the development of measures of productivity. It may be of interest, therefore, to compare the rate of change in output per man-hour for the two countries. The paper by Berlinguette and Leacy does not provide estimates of output per man-hour but does indicate that estimates based on methods similar to those described in their paper are presented in a recent book by W. C. Hood and Anthony Scott, *Output, Labor and Capital in the Canadian Economy, 1958*, Appendix F, Chapter 5, p. 397. A comparison of the figures contained in that volume with our paper indicate that between 1947 and 1955 output per man-hour in the total private economy showed almost exactly the same annual rate of increase for both Canada and the United States—approximately 3.6 per cent. These estimates further indicate a substantial rate of increase for the farm sector—approximately 6.5 per cent for both countries. This sharp rate of increase for the postwar period in output per man-hour for the farm sector was a major factor in the over-all change in output per man-hour.

The rate of increase in the nonfarm sector was 3.0 per cent per year in the United States, compared to 2.5 per cent in Canada. This seeming paradox—approximately the same rates of change for total private and farm sectors but a higher rate in the United States for the nonfarm sector—is due to the greater effect of the farm-nonfarm shift in Canada than in the United States.

The effect of this shift in the United States has already been indicated in our paper. These estimates indicate that approximately 8 per cent of the total increase could be attributed to this shift during this period. The effect of the shift was of more importance in the Canadian economy, accounting for approximately 15 per cent of the total over-all increase in output per man-hour. The greater effect of the farm to nonfarm shift in the Canadian economy is due to the fact that the farm sector accounts for a higher proportion of both man-hours and output in the Canadian economy than in the United States.