Problems in Measuring the Growth Rate

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INTRODUCTION

In recent years it has become fashionable to measure the country's economic progress in terms of what is called the "growth rate", which is the annual percentage change in gross national product at constant market prices. Indeed this growth rate has become one of the most important of our statistical indicators and it is mentioned in nearly every article referring to the state of the economy. We are often told that we are now one-third better off than we were in 1958 and this figure is, of course, based on estimates of gross national product (G.N.P.) or gross domestic product (G.D.P.). It seems to be useful, therefore, to place on record certain facts relating to the measurement of G.N.P. (or G.D.P.) at constant market prices, which is a measure of our national production in volume terms. The present is an opportune time to do this since the Central Statistics Office inaugurated last year a series of figures for G.N.P. at constant market prices. Another reason for the present interest in constant price estimates is that the Programmes for Economic Expansion are based on projections of national accounts data in constant prices. It is of fundamental importance that the planners should know precisely how the constituents of G.N.P. at constant prices are compiled in order to appreciate what projections of these constituents at constant prices mean and to determine what growth rates are feasible in the different sectors of the economy. Furthermore, if economic planning targets are to be intelligently debated, some knowledge of the methods of compilation of constant price data must be imparted to those who use the data. Finally, to measure the degree to which targets are achieved, it will be necessary to compile future estimates of G.N.P. and its constituents at constant prices as well as at current prices, and, for any intelligent comparison of the results, it will be essential to know the fundamental reality behind the figures.

In this paper, therefore, I propose to describe how G.N.P. at constant prices is derived and to indicate some of the difficulties experienced in what is called "deflating G.N.P. to constant prices". Such information will help, I hope, to instil caution in the users of the national accounts, who may not be aware of the considerable difficulties involved and the approximations which have to be made in compiling data at constant prices. Furthermore, it is hoped that the information provided will elicit in due course suggestions for improvement from the users of the statistics.

Gross national product and expenditure

The national output can be measured in different ways. The first method is to regard the output as the sum of the values added in production in different economic units. When these values added are aggregated we derive the national product, i.e. the value of the output of goods and services produced in the economy free of duplication. The values added

also measure the incomes accruing to the factors of production (capital, labour, entrepreneurship) and these, when aggregated, comprise national income. The national income can be regarded as being used for expenditure on the national product, which is made up of consumption expenditure, capital formation and net investment abroad. The expenditure on the national product is thus equivalent to the national product. These measures of output can be compiled net (exclusive of provision for depreciation of fixed assets) or gross (inclusive of provision for depreciation) and they can be valued at either factor cost, which is the total of the payments to the factors of production engaged in producing the goods and services, or at market prices, which are the prices paid by the purchasers. Market prices include taxes on expenditure net of subsidies while factor cost prices do not. All this relates to values in prices of the current period, of course.

The compilation each year at current prices of such an aggregate as national product is not completely satisfactory for economic analysis. Changes over time in the value of national product or its constituents may be due to changes in volume (referred to sometimes as "real" changes) or to changes in prices. It is clearly important to examine volume changes and price changes separately and, for this purpose, value changes should be factored between volume changes and price changes. When reference is made to quantities or volume in relation to goods one instinctively thinks of weight such as the weight of iron produced or other units of quantity such as kilowatt-hours of electricity. Clearly to add diverse quantities such as these a common unit must be chosen and the unit is the monetary unit in a particular year called the base year. Thus quantities of various commodities can be expressed in terms of base year prices and then aggregated. This is the principle behind the compilation of G.N.P. at constant prices.

Using the two compilations, gross national product at current market prices and expenditure on the gross national product, it is possible to make independent corresponding estimates at constant prices. The output method consists of adding together the contributions of the different industries and services to G.N.P., valued at base year price, while, using the expenditure approach, the expenditures on different categories of final goods and services at constant prices can be compiled. For many years official G.N.P. figures at constant prices have been based on the expenditure approach and, indeed, certain categories of expenditure were compiled at constant prices in the first White Paper on National Income and Expenditure, published in 1946.[1] The first official estimates of G.N.P. based on the output method were published in National Income and Expenditure, 1965, and these have been slightly modified in the 1966 issue.[2]

Purpose of compiling estimates at constant prices
Estimates of G.N.P. or G.D.P. at constant prices are required for two main purposes. These may be briefly described as:
  (1) to measure the welfare or satisfaction of the community derived from economic activity;

(2) to measure the productivity and resources of the community for the production of goods and services and to study problems in relation thereto.

The emphasis in (1) is on the consumer while the producer is concerned with (2). The use of real national product in connection with measurements of welfare or productivity is, of course limited. For instance, the transactions entering into national product are those that occur in the market and can be measured by a value, together with certain imputed transactions that can be given a value. Not all processes that contribute to human welfare are included in this definition. For instance, the unpaid services of housewives are not included in the national product, nor is the amount of leisure enjoyed by the community in various ways.

For welfare measurements it is clear that national product should be valued at market prices, which are the prices actually paid and which include the effect of taxes on expenditure less subsidies, for, in measuring welfare, the purchaser of a commodity is concerned with comparing the price of the commodity with other commodities on the market. On the other hand, for productivity estimation and the measurement of resources, the producer is concerned with the cost of producing the commodity in terms of payments to the factors of production and this cost excludes taxes on expenditure less subsidies. It is, therefore, desirable to compile G.N.P. at both market prices and at factor cost.

I—CONCEPTUAL AND PRACTICAL PROBLEMS

Quantity or price?

Difficulties can occur in factoring the value of commodities between quantity and price and, in fact, purchasers and sellers would sometimes disagree as to the division between quantity and price. Take, for instance, the situation arising when there is an increase in the distance over which goods are moved between producer and consumer resulting in an increase in the price charged for the goods. From the producer's point of view such an increase is regarded as an increase in the volume of transport services included in the goods in question while, on the other hand, the consumer sees the increase as purely a price increase since the physical nature of the goods has not changed. To preserve a balance between product and expenditure, consistency must be preserved between the views of producer and consumer. One solution is to treat the greater distance of haulage of the goods as an increase in quantum both for the producer and the consumer, thus implying that the purchase of the goods is treated as divided between the purchase of the goods themselves and the purchase of the transport services embodied in the goods. Another solution is to treat changes in the distance of haulage as price changes at the expenditure side. Balance is then achieved by treating the increased volume of transport services rendered as an increase in input of the distribution trades, thus altering the gross value added of the distribution trades in constant prices. In practice the statistical data available are usually not comprehensive enough to apply either of these solutions and any discrepancy between the

production and expenditure sides of the account would be taken care of in errors of estimation.

In the case of most construction projects a division between price and volume cannot be made directly. Both volume and price indexes are usually based on inputs of building materials and labour. Sometimes these indexes take into account changes in labour productivity and profit margins.

Quality Changes

The elimination of the effect of quality changes from price statistics is another problem which has engaged the attention of statisticians. Many commodities show a quality change over a period of time and it is necessary to allow for this when compiling a price series. To some extent the problem is minimised by subdividing, in as great detail as possible, the commodities to be priced. Furthermore, when two different varieties of the same article appear on the market at the same time a linkage can be effected between the prices of the old model and the new model. This cannot be done however when a new model suddenly replaces an old model. Here it is quite difficult to allow for a quality change except in the trivial case where identifiable additions which can be priced are made to a model which remains otherwise unchanged, such as a heater or windscreen washer on a car. A practice adopted sometimes is to enquire of manufacturers what proportion of any price increase they attribute to changes in quality. There is a valuable discussion of the quality problems in a recent paper by Geary and Pratschke.[11]

Quantity and price of services

While problems arise in the estimation of goods at constant prices the estimation of services at constant prices is more difficult still. The factorisation of value into quantity and price for some services raises both theoretical and practical difficulties and, in many cases, adequate statistical data for this purpose are not available.

Transport and trade services occur in connection with goods but there is a tendency for both purchasers and sellers to look upon quantity as merely the goods traded, whereas the same article may involve different transport and trade services. The case of transport has been referred to above. As regards trade services there is a difference in the services provided by large self-service shops and small shops engaged in distribution. As an approximation, however, it is generally assumed that the services provided depend on the quantities of goods traded.

For transport services, estimated from production data, quantity and price can usually be determined. For different types of transport the number of persons and quantities of goods carried are recorded and distance travelled are also recorded, so that quantities of transport services can be compiled. Information is also available regarding charges for passengers and freight.

The factoring of financial services into quantity and price components raises considerable difficulties and some countries measure output of these

services by the number of persons engaged, with possibly some allowances for increased productivity. Indications are usually available for some banking services such as cheques cleared and the volume of activity in other services such as those in relation to loans and deposits can be approximated by deflating current values for such items by an index to allow for the fall in the value of money. For insurance services the number of new policies may be used as indicators of the quantity of services provided or premium income can be deflated by suitable price indicators.

For hotels, restaurants, cinemas and laundries some attempt can be made to provide volume indicators for the services but in the case of professional services the numbers engaged are usually taken as a volume indicator of services provided.

Services provided by public authorities

These fall under several categories and include defence, education, health as well as public administration. Attempts have been made to quantify the service of education and health by considering the number of pupils in educational establishments and the patients treated in health services. However, these measures are unsatisfactory because they take no account of the quality of the services provided. For instance – if the number of teachers or doctors increases while the number of pupils or patients remains the same it is reasonable to assume that there is an increase in quality. By using pupils and patients, however, as volume indicators, there is an apparent drop in productivity of the personnel in these industries. For this reason it is usually considered preferable to use numbers of persons at work in education and health as volume indicators, with possibly some allowance for increase in productivity. Some counties impute productivity changes equal or proportionate to those in other sectors of the economy.

It appears to be even more difficult to quantify the services of public administration and defence and the solution generally adopted is to regard members at work (allowing for different grades) as an indicator of volume of activity. This, however, is not satisfactory as it implies no productivity change, whereas, with improved organisation and the growing use of technical aids, such as computers, better training facilities, etc., it is evident that productivity is increasing. The difficulty is to obtain a satisfactory measure of this increase.

The problems which occur in attempting to measure output and hence productivity are extremely difficult but, with the high proportion of total national output arising in the government sector, it is a matter of urgency to examine and solve them. In recent years the United States has tackled the measure of productivity in certain government organisations dealing with accounts, fiscal services, insurance, land management and postal services.[7] In most of these cases well defined operations have to be carried out by clerical staff, involving form-filling, examination of claims, etc., and it appears to be possible to analyse such operations and to quantify them. Similar methods might perhaps be used for coding and punching operations in connection with statistical inquiries. While clerical operations of

this nature could perhaps be quantified there seems to be no way of measuring the output of senior administrators engaged in policy making.

II—OUTPUT DEFLATION – METHODS OF ESTIMATION

The ideal method for compiling G.D.P. in real terms is to value both the gross output of each industry and the intermediate input (materials and non-factor services) at the prices of a base year. This should be done in detail if comprehensive data are available for each industry. By subtracting intermediate material and service inputs from gross output the gross product of the industry is obtained and by aggregation over all industries and services the gross domestic product at constant prices is derived.

In symbols, G.D.P. $= \Sigma(Q_1 P_0 - q_1 p_0)$ where Q and P are the quantities and prices of the commodities constituting the output of the industries and services and q and p are the quantities and prices of intermediate inputs. The subscript "1" indicates the current time period while "0" indicates the base year. This method of compiling real G.D.P. is called "double deflation".

Ireland was one of the first countries to pioneer the method of double deflation. The method was applied to Irish industrial statistics in a paper by Geary in 1942,[3] and is also used in the official Irish agricultural statistics. At the present time all the European countries use double deflation for agriculture and some countries use it for industry.

Double deflation may be carried out by valuing the current year's quantities at base year prices or, alternatively, by deflating the current year's values of output and input by suitable price indexes. The second method appears to be more widely used by countries which use double deflation procedures.[8]

Practical compilation problems and lack of adequate statistical data often render impossible the use of double deflation. Most of the alternative methods for compiling real G.D.P. involve the extrapolation of the base year values for individual industries by using a suitable volume indicator. For this purpose the volume of production of the industry is normally used but, in certain cases, the volume of input of materials is used instead. If the ratio of output to input in constant prices remained the same it is clear that these alternative indicators would give the same result as double deflation. However, with the introduction of improved techniques and better administrative procedures into the economy this assumption is not valid.

For certain service industries even the less desirable indicators of the trends in output or input are not available and recourse must be made to the trend in the numbers at work or to the deflation of current values by suitable price indexes.

A description of the methods used to compile G.O.P. in the Irish national accounts for each of the main sectors follows.

Agriculture

Double deflation is used to derive real gross product for this sector. It is clear that this is the appropriate method to use since the ratio of output to

input may vary considerably from year to year due to weather conditions, use of fertilisers, etc. The outputs of individual commodities are revalued at base year prices received by farmers and quality changes are taken into account. The output quantity of wheat is adjusted for quality changes on the basis of information on bushel weight and moisture content and all other commodities are subdivided by grade, where practicable, to allow for quality changes. In the case of some minor items of root and green crops an index of volume change is applied to the previous year's value at base period prices. The value of changes in livestock numbers is obtained by revaluing the actual change in numbers at base year prices.

As regards inputs, quantities of the seeds and most of the feeding stuffs are revalued at base year prices. In the case of fertilisers a price chain index is used to value the fertilisers at base year prices. Some minor items of feeding stuffs are deflated by a general price index of all feeding stuffs. For other expenses, some items are revalued at base year prices while others are deflated by appropriate price indexes or extrapolated by volume indexes.

The valuation adopted in compiling gross product in agriculture is that at factor cost. This means that the products are valued exclusive of any taxes on expenditure levied on them but inclusive of subsidies received by the agricultural sector. The value of gross product derived in this way is, therefore, equivalent to the aggregate income generated by agricultural activity and allowance for depreciation, together with rental income, when the compilation is made at current prices.

Industry

The term industry covers mining, quarrying and turf production, manufacturing, electricity, gas, water and construction. Concerns with three or more persons engaged are covered in the annual Census of Industrial Production. Considerable detail is provided in the annual Census in regard to both output and input.

While, however, a considerable volume of data exists which could be used for the application of double deflation, this method of deflation is not used in practice on account of the quality of the detailed data furnished on Census forms and the resources which would be required to examine and check these data carefully. It is far more laborious to apply the method to industry than is the case for agriculture, on account of the great variety of inputs and the necessity of checking the data for quality changes, price for each variety, etc. For this reason the volume of production of each individual industry (there are sixty industries covered by C.I.P.) is based on a number of single indicators of output in that industry.

Using Census data the value of gross output adjusted for price changes is used in computing the index numbers for individual industries. A Fisher type formula on a chain basis is used. The correlative quantity and value data collected at the Census for the current year and for the previous year are used to derive two price index numbers (one weighted with the current year's quantities and one with the previous year's quantities) to base previous year = 100. The geometric mean of these two indexes is taken as the price index of products of the industry. The total gross output of the

industry for the current year is then divided by the total gross output for the previous year to give a value index based on the previous year. This value index divided in turn by the price index gives the volume index for the industry to base previous year = 100. Some forty-seven industries accounting for about 80 per cent of total gross output have volume indexes computed in this manner. In a few cases, volume indexes can be compiled directly from quantitative output (e.g. cement, malting). For other industries – building and construction, service-type industries and manufacturing industries for which quantities of products are not available (e.g. printing, publishing, etc.) – special methods are used to compute the indexes. Input of materials and/or labour adjusted where appropriate for price changes, are used in most of these cases.

The volume indexes for the major groups and divisions of industry and for all industries combined are obtained by weighting the index numbers for the individual industries within the group or division with their respective net output (a) in the previous year, (b) in the current year. The geometric mean of these two indexes gives the volume index for the group or division to base previous year = 100.

While it must be conceded that double deflation is the correct theoretical method of expressing value added in industry at constant prices it is questionable whether such deflation will, in fact, give better results than the use of a single indicator such as gross output if the data to which the method is applied are not fully comprehensive and quite accurate. It is difficult to ensure that these requirements are fulfilled with the use of limited resources and, since in double deflation the difference between two large aggregates is compiled, quite small errors in the aggregates could lead to diverse movements from year to year in the difference calculated. It does appear that in any application of this method, the results should be examined by reference to the trends in the volume of gross output and significant changes in trend between the two series should be thoroughly investigated. An examination of the application of double deflation to Census of Production was made by Geary and Forecast.[5]

For that part of industry not included in the Census – concerns with one or two men engaged – the trend in volume of production is taken as equivalent to the trend in persons at work multiplied by a productivity index. Recent trends revealed by Census of Population figures are projected forward and any other relevant information available is taken into account. Productivity is assumed to change at one-half the rate measured in corresponding industries in the Census of Production.

Factor cost valuation is used in deriving the volume index of production in industry. Taxes on expenditure levied at the stage of production are excluded while subsidies received are included in the valuation of gross output. However, taxes on expenditure levied on materials used – for example, import duties on motor vehicle parts – are included in the valuation of gross output and the effect of local rates on businesses also influences the price of gross output. To this extent, the valuation used is not true factor cost.

The indexes of the volume of production derived in this manner are

applied to the base year values of gross product in industry (equivalent to employee remuneration, trading income and rental income together with allowance for depreciation) to derive estimates of the real gross product in industry for the other years.

Services

Services cover distribution, transport, communication, public administration and defence, education, health, financial intermediaries (i.e. banks, insurance companies, building societies, etc.), restaurants, hotels, personal services, real estate, entertainment and other business and community services. Together these services contribute nearly one-half of G.N.P. at current prices and, therefore, they have a considerable effect on the overall growth rate in the economy. In many of these services, however, it is difficult to obtain satisfactory measures of output both from theoretical and practical considerations and, therefore, the measure of output must be to a certain extent arbitrary. This is a field where new ideas would be welcome and where international agreement on the measures used would be most beneficial for international recording.

For distribution activities (wholesale and retail trade) a volume indicator of activity is compiled by selecting those goods from personal consumption, capital formation and exports which it is believed move through distribution channels. The value of these goods is expressed at constant prices (see details of expenditure deflation given later) and by aggregating the individual values a single output indicator is derived. This indicator is then applied to the base year gross product in the sector to obtain constant price data for other years. It would be possible to use double deflation for this sector if the required detail on inputs to the sector were available. This has been done by Geary and Pratschke for some years.[11]

Volume figures for the transport sector are also obtained by projecting the base year gross product by means of a volume indicator of output. There are a number of satisfactory measures of output available, such as passenger-miles and freight ton-miles for railways, passenger vehicle-miles and road freight vehicle-miles for road transport, and number of taxis registered. Sea transport indicators used are the net tonnage of Irish vessels registered and the tonnage of all vessels entered and cleared at Irish ports. In the case of air transport, passenger miles, freight ton-miles and capacity ton-miles are available. Within each type of transport the output indexes are weighted by gross receipts while the base year products in the different sub-sectors are used as weights to obtain the overall indicator.

In communication a number of indicators of output are available. For postal services the numbers of letters and other mail delivered are used, while, for telephone and telegraph services, the numbers of calls made, numbers of new stations installed and numbers of new trunk circuits, suitably weighted, are used as a volume indicator of output. For broadcasting services a weighted average of number of hours of sound broadcasting and number of hours of vision broadcasting is used to indicate volume of output. In each case the base year value added is extrapolated by the index of output derived. It does not seem possible to allow for

quality changes in the communication sector, but clearly the quality of the services provided can change over the years.

It is particularly difficult to quantify the output of education and health services since it does not appear to be possible to decide unambiguously upon a quantum unit of output. If the numbers of pupils at educational establishments, or the numbers of pupils passing examinations, are used to indicate output, an increase in the number of teachers, while the number of pupils remain constant, would result in an apparent decline in productivity since quality changes cannot be measured satisfactorily. On the other hand if the number of teachers is used as an indicator of output then an increase in the number of pupils, while the number of teachers remains constant, would not result in any increase in the output of educational services – and this appears to be contrary to common-sense. In this case a compromise has been adopted and the volume index of output is taken as the average of the index of number of teachers and the index of number of pupils. This index is then used to extrapolate base year value added, distinguishing the different types of education.

Health services cause scarcely less intractable problems. Should the number of patients treated be used as an indicator of volume of output? Should bed-days in institutions be used? How should quality changes in the services provided be allowed for? With such problems as these it is hardly surprising that an index based on employment is used as a volume indicator. The volume series is derived by deflating wages and salaries of the persons engaged in the health services by an index of remuneration of local authority employees.

The complex economic transactions of the different sectors and institutions of the economy necessitate the use of financial intermediaries, such as banks, insurance companies, building societies, hire purchase concerns, etc. It is the function of financial intermediaries to supply services relating to the flows of funds between the different parts of the economy and it is this service which constitutes their production. It is, however, difficult to conceive of a volume of output for such transactions and to factor changes at current prices between volume and price changes. In view of these formidable difficulties many countries use employment data as an indicator of output. This does not seem to be very satisfactory as, with the introduction of modern methods of accounting, productivity in these institutions must increase.

In the Irish national accounts indicators of output have been constructed for some of the principal transactions involved. An index of cheques cleared is derived by deflating cheque duties by an index of duties. Bank deposits, deflated by the consumer price index, and bills, loans and advances deflated by the consumer price index, are also used as indicators of output in relation to deposits and loan management. By weighting these indicators an index of volume of output to cover banking is obtained and applied to the base year value added.

For life and industrial assurance a quantum index is based on the average of an index of number of policies issued annually and an index of the value of life funds deflated by the consumer price index. For other insurance a

quantum index is based on premiums less claims deflated by a suitable price index, using a building and construction price index for fire insurance, a price index for motor-vehicle insurance for that business and the consumer price index for other non-life insurance. A weighted average of the quantum indexes is applied to the base year value added.

Similar type indicators have been constructed for other financial institutions and these have then been used to derive value added at constant prices.

For hotels and restaurants the volume indicator used is the number of bed-nights per annum and this is applied to the base year value added.

In laundries, dyeing and cleaning the value added is extrapolated by a quantum index for output based on Census of Industrial Production data.

In private domestic service the value added is extrapolated by means of employment data.

In real estate an index of the stock of dwellings is used to extrapolate value added. The index is derived from bench mark Census data used in conjunction with annual figures for dwellings built and assumptions regarding depreciation.

In auctioneering stamp duties on land and property are deflated by an index of house prices, constructed for this purpose, to derive a quantum index which is then applied to value added.

Public administration and defence causes considerable difficulty. Volume indicators of output are not readily available and, following the usual practice, employment indicators are used to extrapolate value added. This means, of course, that productivity is assumed to show no change.

For some other services which do not contribute much to total value added and for which adequate indicators of output are not available, the consumer price index is used to deflate current values.

The different methods

The methods used for deflating output may be grouped into four main categories and the proportion of gross domestic product at factor cost in each case is shown in the following table:

Method	%
Double deflation	19
Extrapolation of base year value by volume indicator of output or deflation of current value of output by a price index of output *	58
Extrapolation of base year value by number at work or deflation of current values by index of employee remuneration †	20
Deflation of current value by consumer price index	3
All methods	100

*Include some cases in which inputs of materials are used as a volume indicator.
†Includes education in which the indicator is the average of the indexes of the number of teachers and number of pupils.

Over one-half of gross domestic product at factor cost is expressed at constant prices by using a single indicator of the volume of output or deflating current values by a price index of output while double deflation is used for almost one-fifth of gross domestic product. These may be considered reasonably good methods of deflation. However, about one-fifth of the total is deflated by using employment data and it is almost certain that the increases shown for this part of gross domestic product are somewhat underestimated. The residual small part of gross domestic product, amounting to 3 per cent of the total, is deflated by the consumer price index.

III—EXPENDITURE DEFLATION – METHODS OF ESTIMATION

The constituents of G.N.P. are:
　　Personal expenditure on consumers' goods and services at market prices.
　　+Public authorities' current expenditure on goods and services
　　+Gross domestic capital formation
　　+Exports of goods and services ⎫
　　—Imports of goods and services ⎬ =net investment abroad
　　+Net factor income from aboad ⎭
The method used to value these constituents at constant prices is to subdivide each constituent in as fine a detail as possible and either to revalue the items at base year prices or to deflate them by suitable price indexes.

Personal expenditure
　The estimates of personal expenditure at current prices are based on a commodity-flow approach the data in respect of goods being obtained from the annual Censuses of Industrial Production and external trade statistics, supplemented by Quarterly Production data for the latest year. For services the estimates are obtained from a variety of sources, including special inquiries. Personal expenditure is taken as equivalent to home production plus imports less exports.
　Very fine detail is available for goods and, where possible, individual items are revalued at base year prices. Where this cannot be carried out satisfactorily the items are deflated by constituents of the consumer price index or, in a few cases, by special price indexes obtained for this purpose. Most of the food items, alcoholic beverages, tobacco and fuel and power are revalued directly at base year prices while price deflation is used for most of the remaining goods, the price indexes being based on constituents of the consumer price index or, in a few cases, the wholesale price index, The value of farm produce consumed on farms, which is part of personal expenditure, is revealed at base year agricultural prices.
　The estimates for travelling within the State at constant prices are compiled in such a manner as to be consistent with the estimates of volume of output of the transport sector. Base year expenditures on the different categories of transport are projected by means of corresponding volume indicators of output.

A volume indicator of output is also used to express private domestic service expenditure at constant prices, the estimated number of persons at work being used to project the base year expenditure.

For most of the remaining expenditures on services, revaluation at base year prices is not practicable and the figures are deflated by using the consumer price index.

The bench-marks for the compilation of expenditures on rent are figures for the gross rents paid for private housing derived from the 1946 and 1961 Censuses of Population. An imputation is made to cover owner occupied dwellings and the bench-mark rents are expressed at constant base year prices by deflating current values by the rent component of the consumer price index. Interpolation between 1946 and 1961 and extrapolation beyond 1961 is effected by using an index for the stock of dwellings, compiled in the following manner. An opening stock of dwellings in 1946 is derived by assuming a reasonable percentage rate for gross rent in that year. Then by making use of figures for new dwellings and by allowing for losses and depreciation, a stock of dwellings for each year is obtained at constant prices. By relating the 1961 stock of dwellings figure to the gross rent in the same year at constant prices the interpolation and extrapolation referred to can easily be made.

Public authorities' current expenditure on goods and services

About three-quarters of this expenditure relates to remuneration of employees and one-quarter to materials and services. Public administration and defence, health, educational and some constructional and community services form the bulk of the expenditure. Since this expenditure is not sold on the market its value is based on the cost of providing the service and it is not possible to measure the physical volume of output corresponding to remuneration. To be consistent with the output deflation of these services it is necessary to use employment data or employee remuneration deflated by an index of remuneration to extrapolate the base year expenditure in order to derive a constant price series. As in the case of the output deflation this method assumes no increase in productivity and therefore, probably underestimates the increase in volume of expenditure since the base period. The materials and services part of the expenditure are deflated by relevant constituents of the wholesale and consumer price indexes.

Gross domestic capital formation

The commodity-flow method is used to estimate capital formation in machinery and equipment while building and construction expenditure is derived from the annual Census of Production, from figures for new houses built and from government accounts. Machinery and equipment are deflated by appropriate price indexes from the series of wholesale price index numbers. The numbers of houses built each year are revalued at base year prices and allowances for quality changes based on floor area of the buildings are made. It is clearly not possible to use this method for other items in building and construction. Here a wholesale price index of capital goods in building and construction is used to deflate current values. This index

is based on the cost of materials and wages and salaries only and it is, there-
fore, not entirely satisfactory as it does not take into account productivity
changes or changes in profit margins. It might be possible to allow for
these changes retrospectively but this matter has not yet been examined.

The value of the physical change in agricultural stocks (livestock only)
is compiled directly at base year prices by valuing the change in numbers.
Non-agricultural stocks are divided into a number of broad categories and
the change in the current value of stocks is separated into a revaluation
change and a physical change in stocks. For this purpose the series of
wholesale price index numbers is used.

External transactions

Exports and imports of merchandise are valued at base-year prices by
using the official unit value indexes as deflators. Unit values are compiled
for a suitable selection of commodities for which both quantity and value
are recorded. Two price index numbers (one weighted with the current
year's quantities and one with the previous year's quantities) are calculated
and the geometric mean of these two index numbers is taken. Those
invisible exports and imports which can be regarded as services are deflated
by the most suitable price index. For instance, receipts from visitors are
deflated by the consumer price index which is taken as an approximation
to reflect changes in prices of goods and services purchased by visitors.

Factor income to and from abroad does not correspond directly to
goods and services and there is some difficulty about the choice of a suitable
indicator for deflation. However, since a deficit in the balance of payments
is normal in Ireland, it is considered that net receipts of factor income are
used by the community as a whole to finance imports of goods and services.
The implied price index for imports of goods and services is, therefore,
used to deflate net factor income from abroad.

IV—RECONCILIATION BETWEEN OUTPUT AND EXPENDITURE DEFLATIONS

The compilation of G.N.P. based on the output method is made at
factor cost while the corresponding G.N.P. figure based on the expenditure
approach is at market prices. The differences between the two aggregates
is taxes on expenditure less subsidies and to reconcile them it is, therefore,
necessary to express taxes on expenditure and subsidies at constant prices.
Such taxes on expenditure or subsidies enter into the final market price
paid by the purchaser.

A large part of total taxes on expenditure relates to physical quantities
of the taxable goods – e.g. tobacco, alcoholic drinks, hydrocarbon oils –
and it is necessary only to multiply quantities by the base year tax rate to
derive the taxes on expenditure at base year rates. For *ad valorem* duties it
is necessary to deflate the current value of the tax by a price index for the
commodity in question and then to deflate again by a price index of the
ad valorem duty. If there is no tax in the base year then taxes at base year
rates are always zero, while if a tax in the base year is removed, although

the tax at current prices is zero, a tax figure will emerge at constant prices.

If no definite tax rate is stated for a group of commodities an effective rate may be calculated by relating the tax to the value of the group of commodities. Then either an index of the tax rate can be compiled or the base year rate derived can be applied to the figures for the other years.

For local rates a weighted index of rate receipts per £ valuation in county boroughs, county councils and urban districts is used to deflate current values. An alternative method would be to extrapolate the base year value by an index of the volume of rateable buildings.

The same principles can be used to express subsidies at constant prices when these are related to particular commodities. It is rather more difficult to deflate subsidies which are not directly related to commodities – e.g. railway subsidies – and which are paid to cover operating losses. Regarding the subsidy as a negative tax on expenditure used to lower prices leads to the query – what subsidies would be required at base year rates to cover the operating losses of the current year? It seems appropriate to extrapolate the base year subsidy with a volume indicator of output to derive the current year's subsidy at base year prices. This is the practice followed with subsidies which are operating losses and, in effect, it leads to the same volume index of output at both market prices and at factors cost.

The two sets of index numbers of G.N.P. at constant market prices, based on the expenditure and output methods of deflation, are shown in the following table together with annual percentage changes. It can be seen that there is a high degree of correspondence between the two sets of data.

Index of G.N.P. at constant market prices and annual percentage changes

Year	1958	1959	1960	1961	1962	1963	1964	1965	1966
	Index								
Expenditure data	100	104.0	109.0	114.6	118.2	123.3	128.0	130.9	133.1
Output data	100	105.3	109.5	114.6	117.7	121.6	128.4	130.9	133.1
	Annual Percentage charge								
Expenditure data	—	4.0	5.2	4.7	3.1	4.4	3.8	2.3	1.7
Output data	—	5.3	4.1	4.6	2.7	3.3	5.6	1.9	1.7

Conclusion

What can be said about the accuracy of the results? The fact that both methods of approach give consistent results would seem to indicate that the figures are reliable because the two methods overlap for only about one-fifth of the data. This overlap occurs mainly in the public authorities where employment is used both as an output and an expenditure volume indicator and hence it is assumed that productivity has not changed. If productivity is assumed to have increased by 2 per cent per annum in those cases where employment has been used as an indicator of volume then the

index of G.N.P. in 1966 would be 136½ instead of 133, while, if a 4 per cent growth in productivity is assumed, the index would be 140.

The fact that double deflation has not been used for industry, distribution and transport in the output method may be a reason for criticism but it is by no means certain that the use of double deflation would alter the results significantly if it could be carried out not alone for net output in the Census of Production context but for net product in the national accounting sense.

Although the two methods of deflation yield identical results for the total change over the period 1958-66, the two annual changes differ to some extent in most years. This is to be expected. It is evident that the effect of leads and lags between changes in incomes and changes in prices will affect the estimates based on expenditure data since price index numbers are used for deflation in a number of cases. Thus, if the change in prices lags behind the change in incomes for a period, the annual percentage changes, based on expenditure data, will tend to be rather higher than those based on output data. Then, as price changes overtake income changes at a later period, the growth rate, based on expenditure data, will be lower than that based on output data. Of course, to some extent, leads and lags may also effect the output data as price indexes are used in the compilation of some of the volume indexes. Finally statistical inaccuracies and errors of estimation must also cause differences between the two methods.

The most valid point of criticism is that employment has been used both as an output and expenditure volume indicator for about one-fifth of total G.D.P., mainly covering the services of public authorities. It undoubtedly appears that this underestimates the growth that has occurred in this sector, and that, if accurate and reliable volume indicators were available, the recorded growth in G.N.P. over the period 1958-1966 would be somewhat larger than that shown above.

This paper makes no attempt to discuss the fundamental conceptual problems in the services sector, such as questions relating to definitions of output in the health and banking sectors of the economy. All it purports to do is to indicate some of the problems that occur in measuring the volume of production and the growth rate in the different sectors and to review briefly how estimates are compiled at present. I trust that it will be found useful in this respect.

DISCUSSION

Mr. T. J. Baker: I am very grateful to the Council of the Society for inviting me to propose the vote of thanks to Mr. Broderick for his interesting and most salutary paper.

Maximising the officially published growth rate has become in recent years the sacred cow of economic policy. We owe a debt of gratitude to the speaker for reminding us all, in such a lucid manner, of the very peculiar character of the animal we worship.

I hasten to add that this is in no way a criticism of the C.S.O. As we have heard tonight, that office is only too well aware of the practical

and conceptual difficulties involved in measuring Gross National Product at constant prices. The trouble lies with the rest of us, including many of us who should certainly know better, tending to ignore the qualifications, provisos and cautionary footnotes which are scrupulously provided with the C.S.O. Estimates of National Income, and coming to regard the figures, not as complicated estimates, laboriously arrived at, but as hard and simple facts. Worse we rush off to compare these hard and simple facts with other hard and simple facts, obtained elsewhere, by different methods, and draw hard and simple conclusions from our comparisons. If to-night's paper reminds us to pause a little before we indulge in this soft and simple practice, it will have served its purpose well.

Leaving others better qualified than myself, I hope, to comment on the more practical and strictly statistical aspect of the paper, such as whether the use of double deflation could be extended without undue strain on present resources, I should like to dwell a little on the implications of one or two of the basic conceptual problems raised. Specifically the problems of quality changes and of productivity in publicly provided services are exceedingly interesting.

In the first place there is the obvious point that without knowledge of how these problems are tackled in various countries any international comparison of growth rates loses much of its validity. As the figures provided in the paper show, the Irish growth rate from 1958 to 1966 can be shown to have averaged 3.6%, 4.0% or 4.3% per annum according to the assumptions made concerning public sector productivity. These are far from insignificant differences. Smaller, but probably still significant, differences would be obtained through making alternative assumptions concerning the proportion of apparent price changes attributable to quality changes in both goods and services. Where no productivity change is allowed for in the public sector, differences in the definition of public as against private services would also effect quite considerably the validity of international comparisons. Perhaps the speaker could enlighten us a little further on how specific countries deal with these issues.

The second major implication is the importance of these problems in national investment planning. If productivity is assumed to be constant in certain sectors, and volume is measured by an employment index, then any labour saving investment in these sectors has a negative effect on output. Thus if automatic lifts are installed in a hospital, dispensing with the services of a few porters, the effect in National Accounts terms is a decline in the output of the hospital sector, in spite of any improvement there may actually be in the efficiency and quality of the service to patients.

Similarly in services where no allowance for quality is made, investment which improves the service but does not increase the number employed in providing it, or the number of recipients, has no effect whatever on output as measured. An example here might be the provision of a film projector in a school, which at least arguably improves the quality of the education received.

Now so long as these investment decisions are being made on a piece-meal basis by managers engaged in the sectors involved, using criteria

familiar to those sectors, this does not matter too much. But as planning becomes more centralised and more sophisticated, with planning teams consciously attempting to maximise "real" G.N.P. and using such tools as incremental capital output ratios in the allocation of capital, then the likelihood of distortion becomes greater, because *by definition* there is either a negative or a nil relationship between capital investment and output in these cases.

The distinction between productive and unproductive investment which is often drawn is thus one which must be used with great care. In many cases "unproductive" may in fact mean an investment which produces returns which at the present state of knowledge we do not know how to measure, rather than one which produces no returns whatever.

I do not pretend to know the answers to those problems, but clearly the search for them is of great importance. In the meanwhile we should remember to be always on our guard when dealing with "real" National Accounts, and thank Mr. Broderick for helping us to remember.

Mr. J. McGilray: As an economist who is primarily engaged in quantitive analysis I have found this paper of great interest. Economists are apt to rely on fairly sweeping assumptions about the validity of the data which they use, and it is salutary to be reminded of the small print. On the other hand, it may perhaps be interpreted as a compliment to the C.S.O. that we have such faith in the validity of official statistics.

May I first remark briefly upon the conclusions of this paper? In view of the obvious complexities involved, it is of great interest that the results of the two methods of deflation are so close although, as the author has explained, the two methods are not wholly independent. Presumably, however, the output deflation method developed by the C.S.O. has been subject to trial and error. It would be interesting to know if there was initally a greater degree of divergence between the two sets of estimates and if there was any particular bias in the output estimates vis-a-vis the expenditure estimates.

The problems involved in measuring the outputs of agriculture and industry at constant prices seem almost trivial in comparison with those which arise in measuring the output of services, including public authorities. Clearly a great deal of work remains to be done in this area, in which the most difficult problem is the measurement of productivity changes. In services generally, there is no obvious relation between output, numbers employed and productivity, as there is in the case of manufactures. While a variety of imaginative techniques are being developed to measure volume changes in particular service activities, for a large proportion of the services sector employment must remain the main indicator of output. In these circumstances it seems reasonable to allow for some built-in productivity change, based perhaps on productivity changes in the industrial sector.

Despite the considerable improvements in the collection and analysis of national accounts statistics, it is right to be cautious about the use of constant price G.N.P. data for various purposes, particularly for inter-

national comparisons. For example, figures of G.N.P. per capita are often used for international comparisons of welfare, or to compare rates of growth in various countries. For a number of reasons including differences in the methods of collection and processing of statistics, such comparisons are of limited value. However, from a practical point of view, measures of G.N.P. at constant prices provide the best indications of changes in the standard of living. We may not be one-third better off now than in 1958, but at least it may be claimed that we are substantially better off: perhaps we were not 1.7 per cent better off in 1966 compared with 1965, but at least it may be claimed that we were not worse off and that we were probably slightly better off. In addition, indexes of G.N.P. at constant prices are essential as bench marks for planning or projections.

Thus, despite the risks and qualifications attached, constant price estimates of G.N.P. are important and widely-used indicators of economic performance. It is therefore extremely interesting to learn in some detail the techniques used to obtain these estimates and the difficulties encountered May I conclude by congratulating Mr. Broderick on this stimulating and informative paper.

Dr. Geary: Some of Mr. Doyle's comments bring to mind the concluding sentence in the speech of Mr. Sean F. Lemass, then Minister of Industry and Commerce, at the Centenary Banquet of the Society in 1947: "The best things in life are not measurable by statistics and we may fervently pray that they will remain so". The remark elicited a storm of applause from all the statistician diners. Of course, there is more to economics and sociology than the single figure of G.N.P. Most users of the figure for this and other countries are conscious of its statistical deficiencies, yet it is essentially useful. From the start (and Ireland was one of the first countries officially to produce national income accounts) we were aware of the need to highlight the statistical quality of the constituents. This we did by according to each principal constituent a grade A (firm figure), B,C,D,E, (guess). We were widely praised at the time (1946) for doing so. The great improvement in the estimation of the constituents of G.N.P. since those early days will be evident from the paper and I am sure that the efforts of C.S.O. are constantly directed towards further improvement. Mr. Doyle does not need to be reminded that, for planning, the vast multitude of constituents of G.N.P. are more important than the single figure itself. Let us have no doubts about the essential usefulness of statistics of G.N.P. at constant prices and its constituents. These figures are essential for the ascertainment of productivity, in turn related to the study (and therefore the control) of price inflation, almost the gravest socio-economic problem of our time.

I was particularly struck by the thoroughness and honesty of the paper which will be very useful for us in E.S.R.I. May I remark here that the Institute could not function without the co-operation we get in such full measure from C.S.O.

I would like to comment on just two aspects of this huge problem of estimation of G.N.P. at constant prices namely (i) the double deflation

method applied to industry and (ii) estimation of volume in the important service sector Public Administration and Defence, mindful that Mr. Broderick has asked for suggestions. With regard to (i), would C.S.O. consider adding additional columns to the Census of Industrial Production form asking respondents what the value of constituents of (a) input and (b) output in the current year would have been at last year's prices, in addition, of course, to the existing valuation at current prices? I am well aware of the difficulties but perhaps the experiment could be made on a voluntary basis. As to (ii), it may be enough to indicate that according to official estimates the implicit price index for Public Administration and Defence in 1965 (1958 as 100) was 165 compared with that for total G.D.P. of 130. I do not regard the figure of 165, the result of the assumption of unchanged productivity in this sector, as credible. From the paper it is obvious that the lecturer shares this view. Admittedly as a poor, but in my view a better, alternative would be to assume that increased productivity in this sector is equal to that in the aggregate of other service sectors for which genuine estimates were made.

Long ago the request for sanction by the head of a large department for "half a Writing Assistant" caused much hilarity. But it implied, at least, ability to measure work in the public service. I suggest that heads of small subsections should be asked to evolve a quantum measure of work done, on the basis of letters received and issued, documents handled etc., etc. We had some success with this method in my days in C.S.O.

Mr. Broderick: In replying to the discussion, thanked the speakers for their comments. The views of the different speakers were most interesting and he could agree with these views except with those of Mr. Doyle who seemed to cast doubt on the usefulness of national accounts compilations on account of the revisions made from time to time to the figures for earlier years. As Dr. Geary had pointed out, however, the figures were useful in relation to policy considerations even though sometimes they gave only broad indications of trends in the economy.

Mr. Doyle had pointed out that not every aspect of human welfare could be covered in national accounts and, of course, there was universal agreement that other matters had to be considered when assessing the level of human welfare. The actual figures derived for the growth rate depended on the assumptions made in the compilations, and, therefore, the author agreed that it was not valid to compile figures for output per person in some sectors of the economy – e.g. services. Indeed, some of the revisions to figures referred to were caused by changing the methods of compilation. For instance at one period "real" government expenditure was compiled by deflating the current value by the consumer price index, whereas, the greater part of real expenditure is now compiled by using employment indicators. A change like this causes substantial revisions to figures published in previous years. As regards Mr. Baker's query on productivity changes in the public authorities' sector, Mr. Broderick thought that Germany and some other countries allowed for productivity increases when compiling their national account figures at constant prices while

Britain and Ireland assumed no productivity increase. Such differences affected international comparisons. As Dr. Geary had pointed out, if each government department were asked to measure its output some progress towards the measurement of genuine productivity changes could be made.

Regarding the suggestion that it was preferable to compile figures on a net basis, exclusive of depreciation, the difficulty here was that the methods used to measure depreciation varied between countries and even between different sectors in the same country. There was some doubt, therefore, whether net figures were as meaningful as gross figures.

Mr. McGilvray had inquired whether any greater divergence between the output and expenditure figures had arisen when different methods had been investigated by the C.S.O. in obtaining the output figures. Mr. Broderick said that only very slight deviations from the figures eventually published had been obtained. For instance slight differences would arise if the assumption regarding productivity changes for persons in small industrial concerns were changed. Mr. Broderick agrees with Mr. McGilvray that input/output tables would be useful in double deflation.

As regards work which remained to be done to improve the estimates the author suggested the following:

(1) Identification of unit of output for government services and other important services such as education, health and the services of financial intermediaries.

(2) Improvement of price indexes for building and construction by allowing for productivity changes and profit margins.

(3) Assessment of quality changes.

(4) Co-ordination between general price statistics and national accounts data.

(5) Investigation of concepts and methods to be used to obtain a complete set of national accounts at constant prices – a subject not referred to in the present paper.

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