SOME PROBLEMS IN THE MEASUREMENT OF CHANGES IN THE REAL GEOGRAPHICAL PRODUCT

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I. INTRODUCTION

THIS paper represents the firstfruits of work being done jointly by C. F. Carter, Richard Stone and myself, and I would like to start by acknowledging their assistance in what is really a joint undertaking; I would also like to start by apologizing to the audience for the fact that these firstfruits have been picked before they were fully ripe. We hope that the discussion which follows their premature exhibition at this meeting will help us to improve the quality of the main crop when it finally appears.

Our objective may perhaps most easily be visualized as the extension of our index of industrial production,[1] on an annual basis, to cover the whole economy. More precisely, we shall be aiming at measuring in real terms the year-to-year movements in total output of the United Kingdom – what is sometimes called the 'geographical product'; we include in the field, by a fairly natural extension, the output of the British shipping industry, but we exclude all dividends etc. received from overseas.

It is perhaps useful to remind ourselves of the general principles of that technique, and to show how it is related to national income statistics. I shall take for illustration a simple case in which all problems connected with the government and with foreign trade are assumed away.

The procedure is, then, to take the gross geographical product at factor cost for the base year and divide it up between the various 'industries' in which it was created. As we shall see later, the 'industries' used for this purpose may not be defined in quite the same way as for other purposes, but that need not detain us here. Opposite each industry we put what I shall call its 'net output' in the base year. Strictly speaking, this figure is not the 'true' net output (i.e. the sum of the incomes accruing to the factors of production engaged in the industry), because

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[1] See *The Measurement of Production Movements* (1948), by C. F. Carter, W. B. Reddaway and Richard Stone. This publication is the first to appear in the Monograph series of the University of Cambridge Department of Applied Economics, which is published by the Cambridge University Press.

it includes depreciation; on the other hand, it is smaller than the 'net output' as defined for Census of Production purposes (i.e. selling value of output less cost of materials etc.), because *all* outside purchases are deducted, such as payments for advertising or business travel, instead of only a limited class. By definition, the sum of the net outputs of all industries on this basis must equal the gross geographical product at factor cost.

For each industry we then need one or more indicators, which ideally should reflect, in real terms, the proportionate change in the industry's net output between the base year and any other. Multiplying the base-year net output by the output relative we then get the net output of later years at base-year prices, and can prepare a table of this kind:

Industry	Indicator(s) used	Net output at 1946 prices			
		1946	1947	1948	1949
Cotton spinning	Weight of single yarn produced (5 types)				
Cotton doubling	Weight of yarn doubled				
Cotton weaving	Linear yardage of cloth woven				

We can add up the figures in each column for any desired group of industries, and turn them into index numbers if we prefer that form, as well as computing a total.

I would like to stress that in principle it is changes in *net* output, measured at base-year prices, which the indicators should show. We frequently use what is really a measure of changes in *gross* output, but strictly speaking that is only justified on the assumption that each unit of output will always imply a constant quantity of outside purchases; frequently this is approximately true – output and input are in a constant relationship – but there are some important exceptions, particularly in regard to the input of certain services purchased from outside the industry (e.g. advertising), and there may be major changes in technique.

Logically, I think the best approach to the problem is that described by Geary[1], according to which both the output and

[1] See 'The Concept of Net Volume of Output, with Special Reference to Irish Data', by R. C. Geary in *Journal of the Royal Statistical Society*, Pts. III-IV, 1944, pp. 251–9.

the input of each industry in any year are recorded at base-year prices (or estimated on that basis), and the difference gives the required net output. This has the advantage of making it clear that the result is logically the same, whether you work from the net outputs of all the various industries (including those making intermediate products), or whether you work from the expenditure side of the national income tables, and express consumption and capital formation at base-year prices. For if we have recorded the total output of (say) coal in 1948 on the output side, and deducted the coal used by all the various industries on the input side, we must be left with the coal bought by domestic consumers and the coal added to stock at all stages,[1] i.e. with the coal which should go into the final expenditure table. Furthermore, the valuation should be the same, e.g. it will include transport and distribution charges, since the value added on this account will have appeared as part of the net output of the transport and distributive trades, or of the industries supplying them with materials.

Needless to say we cannot in practice apply Geary's technique to many of the industries, but it is very important to be clear about the logical principles when making the inevitable approximations. This applies particularly to agriculture, where changes in technique have been very substantial, and which we hope to treat on Geary's lines; this will ensure, for example, that an increased output of artificial fertilizers does not have an exaggerated effect on our total index – first in the fertilizer industry, and secondly through higher agricultural yields, with no offsetting allowance for increased *input* per ton of potatoes. It is also important in suggesting that certain 'industries' which supply their output wholly to others should be grouped with the latter as a single industry, so that there is no need for any measure of output at the intermediate stage.

Having briefly indicated the relationship of our approach to that which starts from the figures of final expenditure, I would like to emphasize that neither can claim any monopoly of virtue. It is highly desirable that both should be undertaken, not merely so as to have an independent check on the grand aggregate, but also because the methods automatically give figures for quite

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[1] Plus, in the case of an open system, the coal exported. If we are dealing with an open system, the volume of consumption plus capital formation will move differently from that of output if the terms of trade change or dividends etc. from abroad move differently from output.

different sectors of the total – one dividing it by 'industries of origin', the other by types of final expenditure – and both sets are useful. The greatest advantage of the industry approach is probably that there are more and better quantity data for basic products than for final expenditure, so that the area in which we are dependent on uncertain price adjustments is considerably reduced.

Finally, I would like to conclude this section by emphasizing the care with which any figures of 'real national output' must be used in drawing any deductions about welfare. The limitations are, of course, the same as when one starts from the final expenditure table – with the addition, in the case of an open system, of the fact that allowance must be made for changes in the terms of trade and in income from overseas. This may perhaps serve as one example of the general proposition that the figures only aim at measuring *changes in the flow of goods and services becoming available to the community through its economic activity*; they make no allowance for changes in the power of those goods and services to generate welfare, or of other sources (or destroyers) of welfare. Thus if a cold winter increases the need for fuel to maintain our homes at the old temperature, and that fuel is produced, the volume of output (and consumption) will be shown as rising, even though welfare is not increased; similarly if the international situation inspires us to build more battleships and air-raid shelters, or the fear of plague leads to the increased use of vaccines. We have thought it useful to measure the expenditure, at base-year prices, on certain large and fluctuating items (notably defence), which may perhaps be regarded as 'regrettable necessities' rather than as contributing to welfare; the subtraction of these from the total may be regarded as the first step towards assessing changes in welfare. But the list makes no claim to be exhaustive, even of those items which might be considered to fall *wholly* into this category, and it does not attempt to deal with those for which a variable part should be so classed (e.g. that part of travel which represents the 'necessary evil' of travel to and from work); and, of course, there will always remain both the difficulty that the prices of a particular base year have no real claim to reflect welfare, and all the incommensurable problems of changes in needs, tastes, etc.

II. SOME LOGICAL PROBLEMS

In this section I wish to examine the general scheme of things outlined above with particular reference to a number of problems which cost us a good deal of anxious thought. On looking back it seems that much of this perplexity should have been avoided, since the answers appear relatively obvious when once the general key has been found; but it may be useful to go over the ground, and it may be that there are objections to these 'obvious' answers which we have not perceived.

The first set of problems is concerned with *changes in external circumstances*. An example will perhaps serve best to show the issues at stake. If there is a bad winter the amount of repair work which is needed will increase (e.g. mending burst pipes, replacing roof tiles, etc.). Is it right that the output of the repairers should be shown as having increased, and, still more, is it right that the total output should show a rise? On the other hand, the bad winter will probably reduce the output of some industries (e.g. agriculture) 'through no fault of their own'; is it right that their output should be shown as having fallen? The upshot of our discussions seemed to be quite clearly that we must stick to the plain facts about output *and input* for each of the industries, and then add up the results to give the figures for net output as a whole. Quite apart from any question of the desirability of doing something else, which is very doubtful, it seemed clearly impracticable. Thus the result of the bad winter would be inextricably embodied in the figures of agricultural output, and it would be impossible to adjust these to the yields which might have been expected if the winter had been 'normal'. Similarly, the output of the repairing industry would almost inevitably include the amount of work done to make good the ravages of the abnormal weather in the same figure as the 'normal' work of repair. The same thing is true whether the change in the external circumstances acts on the *supply* side (as with agriculture) or on the *demand* side (as with the repairs). It also seems to be irrelevant whether the change is truly external or uncontrollable, as with the temperature, or whether it is to some extent within man's control, as in the case of a slump or an inflation. We pass no moral judgement on any industry when we record the fact that its output has risen or fallen – the reason may be the weather, the industriousness of the

workers, the lack of demand, or anything else.

It is perhaps worth stressing that the effects of these external changes may influence either the *output* side of an industry's account or the *input,* and a proper measure of changes in net output should take account of both. Thus if bad weather is causing the farmers' tractors to need a lot of repairs, the input of repair services into the agricultural industry should be shown as increasing, and the net output reduced in consequence, just as effectively as if the yield of the harvest had been reduced. An important consequence of this is that we should not have any feeling of repugnance against entering the increased output of repair services by the repairers as a rise in the national output; our statistics, if properly compiled, will not show any net rise in aggregate output merely because our tractors are breaking down more frequently.

Perhaps it is useful to sum up our conclusions on this topic by saying that changes, whether external or internal, which affect *the ease of producing an output* will get their effect incorporated automatically into the index both for the industry in question and for the aggregate; this is, of course, as it should be if the index is to measure the volume of goods and services produced. On the other hand, those changes which affect *our needs in our capacity as consumers* are ignored by the index, and if we want to make any judgements about changes in welfare these must be allowed for on the other side of the account. For example, if the output of coal for domestic purposes is increased we can say nothing about welfare on the fuel side unless we first consider whether more fuel was needed to give the same temperature in the homes (e.g. because of a cold winter, or because windows have been broken by bombing), or whether the extra fuel will, in fact, have led to a desirable increase in warmth. Sometimes opinions will differ about what is desirable – e.g. the increased output (and consumption) of ice cream in a heat wave may be regarded by some as 'a good thing' or 'a positive contribution to welfare', but by others as a regrettable necessity.

This brings me fairly naturally to a second set of problems, which are concerned with the decision as to what is to be regarded as the unit of output in particular cases. The one which actually featured most largely in our discussions was the case of medical services. Here again our difficulties partly arose out of an instinctive objection to saying that the national output

increases when there is an epidemic, which would be the con-
sequence of taking something analogous to 'a doctor's visit' as
the unit of output (at least if the epidemic were confined to
dependants). It seems clear, however, by analogy with the cases
discussed above, that this sort of instinctive objection must
simply be overruled. We cannot expect our index to reflect this
kind of 'welfare' consideration – it is fundamentally concerned
with those of the market-place. The proper procedure seems to
be to consider what the unit of output is for which the doctor
is normally paid. In the olden days this would almost certainly
have been something analogous to 'a doctor's visit' or 'an
operation performed'; we would have got the same result as
with the house repairers discussed above. On the other hand,
it is conceivable that the 'normal contract' between the doctor
and the patient would provide that there was to be a fixed pay-
ment for whatever medical attention the patient in fact needed
in the year, so that the unit of output could be thought of as 'a
year's attention' (presumably of a given standard), and the
effect of the epidemic on the medical industry would be analo-
gous to the effect of a bad winter on the farmers – i.e. it increases
the difficulty of producing the same output. In a community
with a national health service which is run rather on this prin-
ciple there might seem to be a fairly strong argument in favour
of adopting this view – not because it coincides more nearly
with 'welfare' considerations, but because it corresponds to
what happens in the market-place. It has the somewhat para-
doxical result that the output of medical services might even be
shown as *falling* in an epidemic (because of the inevitable re-
duction in the standard of attention received by patients) whilst
the output of medicines would almost certainly be shown as
increasing, since in this case the payment to the industry is
proportional to the quantity delivered.

Even worse difficulties arise, as we shall see later, in con-
nexion with some of the government's activities, but it seems
best to postpone consideration of those to subsequent sections.

Another important consideration in measuring the output of
certain industries is that it may in principle need to be recorded
under a large number of sub-categories. This is clearly true in
the case of different qualities of an article, but it may also be
important in such respects as geographical position. If we con-
sider the industries of coal production, transportation and dis-

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tribution together, it is not sufficient to measure their output simply in terms of the number of tons of coal delivered to users. A ton delivered to a destination far from the pits should be considered more valuable than one delivered within a radius of a mile, and we should have separate indicators for the two kinds. In practice, by adopting the 'net output' approach and treating the three industries separately, we automatically allow for the extra value due to extra transportation; the danger then becomes that with a change in circumstances we may attach *too much* significance to the carrying of coal about the countryside. If, for example, the Kent coalfield were closed and an equivalent amount of coal for use in the surrounding district had in consequence to be mined elsewhere and transported many miles, our index would probably show no change in the output of coal, and a rise for the railways. To avert this spurious rise in the total index one would presumably have to treat the various coalfields as separate industries, in which case the Kent one would be found to have a *higher net output per ton than* (say) the Midlands, because its geographical position in a coal-importing region gives it a higher pithead price. A shift of production from Kent to the Midlands would then be recorded as a fall in the index for coalmining as a whole, if one were computed, and this would offset the rise in the railways' index.

So far as *quality changes* in general are concerned, presumably the logical procedure is to try to value the goods or services actually produced by the industry in (say) 1949 at the price per unit which they would have had if that quality had been on sale in the base year. The difficulties here seem to be more practical than logical, though the latter are far from negligible.[1]

The next group of problems are those associated with *changes in technique*, taken in a wide sense to cover switches between the use by an industry of external specialists to do such things as repair and maintenance work, accounting, etc., as well as the more obvious ones of changes in processes. A particularly important one, taken over the long period, has been the progressive shift from the use of power generated in one way or another in the factory to the purchase of electricity from the main suppliers; this normally gets recorded in an index of production as a rise in output, because the power produced in

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[1] The importance of the subject of quality changes must not, of course, be judged by the length of the discussion of it in this paper.

factories was not regarded as part of any industry's output, whilst the electricity industry naturally showed a very big rise.

In principle it seems clear that this group of problems is virtually eliminated by Geary's rule of measuring both output and input of each industry. It does not then matter how much the methods within the industry may change; we have recorded the value (at base-year prices) of what went in and what came out, and the difference is the required figure for net output. There are, however, obvious difficulties about doing this in practice, and there is consequently a real danger that a comparison between a very complex economy and a comparatively simple one will be unduly favourable to the former; I do not intend to discuss these problems further.

Finally, one ought to list here the problems connected with *new products, changes in taste,* etc. This part of the field, however, is a well-trodden one, and I have little to add to the familiar discussion. It is, however, perhaps worth noting that when one is dealing with *net* output some of the problems appear in a rather extreme form. Thus it is possible that the materials etc. used by an industry in 1949 may, when valued at base-year prices, exceed the value of the 1949 output, also valued at base-year prices, so that the net output at base-year prices will be shown as negative. This might happen, for example, if the base-year was one in which corn prices were far too high relatively to those of pork to justify the use of corn for fattening hogs; in a later year the supply of corn might become abundant and its price fall, so that the farmer in fact made a very good profit out of feeding it to the hogs, but the net output at base-year prices might be negative. This result may seem paradoxical, but it is the right one, at least for the economy as a whole[1]: it provides an offset to the fact that the large output of corn in the later year has been valued at the high price of the base year, even though its only use is for feeding to animals.

In certain cases it is probably legitimate to escape the paradoxical results attained by a strict application of the rule about revaluing output and input at base-year prices, by treating the work as though it were done on commission by a contractor. Thus if the base year is one in which it was considered desirable

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[1] It may sometimes produce rather absurd-looking results for particular industries, or even industry groups, but this is unavoidable if we have a single base year.

to build air-raid shelters, or to convert furnaces from oil burning to coal, we should not regard the work of demolition or reconversion as producing negative net output if done in a later year when circumstances had changed and made this appear desirable. Our 'input' (an undemolished shelter or a coal-burning furnace) is worth more when valued at base-year prices than our output (a cleared site or an oil-burning furnace), but so long as the input items are not being currently produced in the later year it seems legitimate to value the adaptation of old fixed capital on a 'work done' basis, using base-year prices for similar work.

III. PROBLEMS CONNECTED WITH THE GOVERNMENT: GENERAL REVIEW

The activities of the government are always difficult to fit into an analysis based essentially on 'market' concepts, because in so many respects it behaves in ways which do not conform to market usage.

The first point to note is that all our valuations in connexion with private industries should be done at factor cost. There are various problems of allocation arising out of this, even with ordinary cash subsidies and taxes, but I do not intend to explore them here; nor do I intend to argue the case for factor-cost measurement in this connexion – it is regularly adopted for index numbers of production, at least so far as major taxes and subsidies are concerned (alcohol, tobacco, sugar, etc.).

Taxes, subsidies and other purely 'financial' operations by governments do not seem to require any further consideration for our index. The troublesome problems arise in connexion with those of its activities which involve the employment of factors of production and the performing of services. How far are these part of the national output, and how should they be measured?

We have not finished our consideration of this very complicated matter, but it seems as though the best procedure is to think of the government's activities as divided into four categories. (There are, of course, some hybrids, but I do not intend to discuss that problem.)

(a) The first category covers those which are virtually commercial operations – e.g. the running of nationalized industries and the work of importing (and sometimes wholesale distribu-

tion) of food or materials; these are treated on the same principles as private industries, and indeed our index numbers will usually cover a certain operation – e.g. gas production, road transport, the importing of timber – whether it is performed by the government or by private enterprise. In a period when many of these activities have in fact been transferred from government to private operation or *vice versa* the results on any other basis would be of little value, and the most natural indicators measure changes in the volume of output irrespective of who is responsible for it.

(*b*) The second category includes those in which the government is supplying a service free, or at a nominal charge, which is designed to assist a particular industry or small group of industries. An obvious example is the agricultural advice service, but many other government activities can be brought under this heading by a slight extension of the basic concept – e.g. the work of the export promotion department represents (free) assistance to the 'industry' of export distribution, the rationing and price control departments may be regarded as helping the relevant sections of the distributive trades to distribute goods in an acceptable way, etc. In most of these cases the best procedure seems to be to group the relevant section of the government (e.g. its agricultural advice service) with the ordinary industry (e.g. agriculture) to give a composite industry, the function of which is to produce the goods or services usually associated with the ordinary industry (e.g. agricultural products). As is explained below, this procedure is not only logically satisfactory, but also renders a great number of statistical problems more easy to solve.

(*c*) The third type of government activity is similar to the second in that it represents the provision of (free) service to business, but in this case the service cannot be regarded as confined to a small group of industries, even if we are prepared to define 'industries' in unusual ways. The government employment exchanges are a good example (though they might possibly be regarded as a service to the job-seekers as individuals rather than to industry), and the supply of general business information probably belongs here, too. This category is best treated by a modified version of the method which is applied under (*b*), taking 'all industry' as the partner instead of a particular one.

(*d*) Fourthly, we have those government activities which are not primarily designed to assist *industry* (i.e. the production of goods and services), but which represent services supplied to *individuals as consumers* (e.g. state education) or to *the community as a whole* (e.g. defence). The second of these sub-groups might in a sense be held to be also a service to 'industry in general' and so akin to the items included under (*c*): it occupies an intermediate position between services to 'producers' and services to 'consumers', in that it represents the work of providing the indispensable framework without which the producers cannot properly produce and the consumers cannot properly enjoy their consumption. For our purpose, however, it seems clearly better to include them in this category, if only because we are building up our total of the gross national product by adding up the net outputs (at base-year prices) of all the various industries, including those making intermediate products. If we wanted to treat defence as a sort of intermediate product rather than as a final good we would have to eliminate not merely the *net* output of the 'Armed Forces' industry, but also their purchases of materials etc., which will have been included in the net output of countless industries as the work of making steel, mining coal, filling shells, etc.; some, indeed, will consist of imports, which have not been included anywhere (unless we consider the production of an equivalent value of exports as 'representing' them). All these bits cannot possibly be disentangled from the other output of each industry concerned, and the proper procedure seems clearly to include the (net) output of both the 'Armed Forces' industry and the 'state education' industry in just the same way as that of the laundry industry or any other.

Having arrived at our total for the gross national product in each year (measured at base-year prices) we can then, if we like, see what is left after we have deducted the *expenditure*, also at base-year prices, on whatever we choose to regard as 'overheads on the economy', 'regrettable necessities' or some other term which we may use to denote things which I would personally regard as a rather peculiar set of final goods.

For attempts to assess changes in welfare it is, of course, very important to make this deduction in the case of regrettable necessities on which expenditure *fluctuates* a great deal, such as defence; on the other hand, the year-to-year movements in

the residue will be much the same, whether or not we deduct the expenditure on the more stable kinds, such as 'central administration' (including tax collection). This makes it less important to attempt a complete list of the regrettable necessities, some of which are not in the government sphere at all (e.g. travel to work); but one must frankly recognize that even a complete elimination of regrettable necessities (supposing it were possible to agree on a list of them) would only be a first step towards a measurement of welfare changes, for reasons discussed in Section I.

It is worth emphasizing, however, that welfare measurements are by no means the only purposes for which these statistics are useful. Thus a study of the gross national product, including the 'output' of defence etc., is helpful as a guide to what might happen under different circumstances – e.g. if the need for expenditure on defence were increased or reduced; the total is, indeed, a significant measure of the *output* of the community.

IV. GOVERNMENT SERVICE TO INDUSTRY

In this section I wish to consider in more detail the treatment of government activities which consist in the provision of (free) services to industry. I shall start with the category in which the service is confined to one industry, taking as an example the agricultural advisory service.

Logically, this situation should probably be regarded as containing two industries – the *advisory service*, whose output is measured in terms of questions answered, lectures given, consultations held, etc., and whose input consists of paper, printing work, business travel, etc.; and *agriculture proper*, whose output consists of farm products, and whose input includes, besides fertilizers etc., the 'products' of the advisory service. Agriculture proper is given in each year a subsidy equal to the value of the *gross* output of the advisory service; the subsidy is not, of course, given in cash, but we can think of it as an ordinary cash subsidy which is used to 'purchase' the advice.

For our purposes all valuations have to be made at base-year factor cost, and the market prices of farm products in that year should therefore be raised by the equivalent of this subsidy in kind, spread over the various products in whatever way is considered most appropriate. The valuation of the 'advice' (both

for output and input) would be on the basis of the cost per lecture etc. to the government in the base year.

Taking the two industries separately, therefore, we ought to measure their net outputs (at base-year prices) in any year as the difference between gross output and input, computed on the following basis:

(a) *Agriculture*

Gross output – tonnages of various products multiplied by the sum of the base-year *price* and the base year *subsidy* (expressed per ton).

Input – number of lectures etc. received in the year, multiplied by base-year cost per lecture *plus* quantities of fertilizers etc. used in the year, multiplied by base-year prices.

(b) *Advisory service*

Gross output – number of lectures etc. given in the year, multiplied by base-year cost per lecture.

Input – tonnage of paper used, number of railway journeys made, etc., valued at base year prices.

If we take the two industries together the lectures etc. will always cancel out, and the net output of the combined industry, measured at base-year prices, will be the gross output of agriculture, valued as above, *less* the fertilizers etc. and the input into the advisory service. Thus we escape the awkward problem of measuring (in quantitative terms) the movements in the output of the advisory service, both for the agricultural index and the 'government advice' index. In the language of bridge, we have not merely 'discarded a loser on a loser', so as to reduce the number of losers by one, but have got rid of both; the only drawback is that we cannot then produce separate statistics for (say) 'agriculture proper' and 'government operations'.

As an approximation we can simplify the above procedure even further. It may be that the input of materials into the advice service can be regarded as moving approximately in proportion to the gross output of agriculture, or is quantitatively of little importance. In that case we would get the same answer by taking the subsidy as equal to the *net* output of the advice service in the base year (instead of the total cost of running it), and ignore the paper, railways journeys, etc., throughout. We shall then be using a lower set of (factor-cost) prices for valuing

the output of agricultural products, but shall not be deducting anything for the input into the advisory service.

This approximation simplifies the computation greatly. For the *weight* of the combined industry we have only to add the net output of the advice service in the base year to that of agriculture, computed without any allowance for the advice, either as input or as a subsidy. The *indicator* of quantitative movements from year to year is the same for the combined industry as it would be for agriculture alone, ignoring the advice.[1]

Before passing on to consider the case of a service to 'industry in general' it is worth pausing to see some of the implications of this procedure and how far it gives a different answer from other possible ones. Firstly, the fact that we pay no heed to year-to-year changes in the output of the advice service does not mean that we regard them as 'making no difference' or 'valueless'. An increase in the amount of advice given may be extremely valuable in that it enables the farmers to increase their output (or cut down their input – e.g. of tractor fuel or spare parts). But this will show itself in the (net) output recorded for agriculture, and it would be wrong to count *both* the increased lectures *and* the extra potatoes which they 'produced'.

Secondly, the fact that we add this 'subsidy in kind' to the weight attached to agricultural output in the base year is a reflection of the fact that more factors of production were really involved in turning it out than were employed in agriculture proper.

Finally, we shall get a materially different answer for year-to-year movements by following this procedure rather than what might be called the normal 'index of production technique' in years when the 'output' of the advice service moves very differently from that of agriculture proper. If we had treated them as two separate industries, each with its own weight and its own indicator of movements in (gross) output, then a doubling of the advice service would have been recorded as a doubling of its own output, as well as being reflected in its effect on the output of agriculture; unless we are optimistic enough to think that the output of agriculture would be doubled, we would have

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[1] Strictly speaking, this is not quite true unless the subsidy is spread proportionally over the different products, but the procedure is the same once the base-year prices (including subsidy) have been established.

exaggerated the rise in total output by ignoring the fact that the big rise in the advice industry implied a higher ratio of input to output for agriculture. Even if we had taken account of inputs actually *paid for*, we should not have escaped this trap.

An extension of this example to the case of controls (e.g. clothes rationing) illustrates important principles. We intend to combine the operations of the rationing department with those of the clothing distributive trades as jointly performing the service of distributing clothing to the consumer. Our base year will be one when rationing was in force, and the weight of the combined industry will be the sum of the net outputs of the rationing department and the clothing distributors; the indicator will be the 'volume' of clothing distributed. When we perform the calculation for 1949 the indicator will take no heed of the fact that rationing ceased in that year; is it really right that the complete disappearance of one part of the combined industry should leave no trace on the index, and that 'output per head' in the combined industry should show a large rise? And does this imply that the rationing department was a mere parasite?

The answers to these questions are clear if we remember the argument in Section II about changes in external circumstances. Thanks to changes outside the sphere of clothes distribution (notably the disinflation policy) the task of distributing clothing in an orderly manner has become easier and rationing is no longer required. The service of distribution is (in this case) performed at least as satisfactorily since rationing was abolished as it had been before,[1] so that the distributive trade is able to produce as large a gross output as before, without the input of services from the rationing department. It deserves no 'credit' for this result, any more than the ex-rationers do, but it is quite *true that real (net) output per head in the combined industry* has risen. The rationing department was no more a parasite in the years when external conditions made it necessary than the breakdown gang is when fog causes a railway accident -- even *though both can be dispensed with under suitable circumstances.*

How, then, do we deal with government activities designed

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[1] This is, of course, a crucial point. The indicator used is not an ideal one, because it takes no heed of any changes in the quality of the service rendered, but for clothes that is approximately what we want for comparisons between periods before and after the abolition of rationing. In the case of sweets the argument would not apply.

to help industry in general, for which the employment exchanges may serve as an example?

Logically the problem is similar to the one discussed above.

(a) The employment exchanges should in principle be treated as a separate industry, with a *gross output* in any year equal to the number of placings, valued at base-year cost per placing, and an *input* of paper, telephone services, etc., also valued at base-year prices.

(b) For the base year we should allocate this gross output of placings between the using industries in whatever way we think most appropriate; we should then regard these as receiving a subsidy of that amount, thereby raising the factor-cost price of their output, and also spending that amount on input of exchange services.

(c) For later years the *output* of all using industries should be valued at the enhanced prices found under (b), and we should allocate the gross output of the employment exchanges found for that year under (a) as inputs of using industries, taking the proportions considered most appropriate to the year in question.

For employment exchanges it might be possible to follow out this procedure in full, if only approximately. It would, however, require a lot of work for a relatively small reward, and with other services it would involve a great many arbitrary decisions. Two stages of approximation to the result can be used, as follows.

As a first simplification we can decide not to allocate the use of the exchanges between industries, either in the base year or later.[1] We still include a series to represent their net output in each year, and we still regard the value of their gross output in the base year as both a subsidy to other industries and an element in their input. But we simply add the subsidy as a bulk item at the bottom of the table – 'addition for undervaluation due to non-allocation of subsidies in kind' – and we also subtract the input as a bulk item at the bottom – 'deduction for unallocated input of government services to industry'. In the base year the addition and deduction are equal, being the gross value of the services in both cases. In later years, however, the *addition* is a constant percentage of the total net output at base-year prices, because we simply assumed that spreading the sub-

[1] More strictly, we assume that in the base year it is proportional to the net output of each industry.

sidy would have raised these prices by X per cent; whilst the *deduction* represents the value (at base-year prices) of the services rendered in the year in question. If the exchanges were abolished the series for their own net output would, of course, fall to zero, and so would the deduction for input into other industries, but the addition for under-assessment of base-year prices would remain. The *direct* effect of the abolition would thus be a *rise* in total output corresponding with the fact that paper, telephone facilities, etc., would no longer be absorbed as input into the employment exchange industry – quite apart from the possibility of the staff and buildings being put to alternative uses. The *indirect* effect would doubtless be a fall in the output of other industries, and we may perhaps assume that this would out-weigh the direct rise.[1] The important point for us is that these indirect effects will be reflected automatically in the statistics, and we need not be alarmed at the apparently paradoxical direct ones.

So far as the final figure is concerned we could get the same answer by taking the net output of ordinary industries (ignoring the employment exchanges etc.), *adding* X per cent to represent the subsidy in kind, and *subtracting* the input of materials into the employment exchanges, all values being at base-year prices; for in the procedure described above we included the *net* output of the exchanges in the body of the table, and deducted their *gross* output at the bottom, so that on balance we were sub-tracting their input.

If the input of materials etc. into the employment exchange service is always small, or can be regarded as moving roughly proportionately to the gross national product, then a second simplification is possible: we would get approximately the same result by reducing X appropriately and ignoring the employment exchanges altogether so far as year-to-year movements are con-cerned. This is, of course, just what was described for the single-industry case, but taking 'industry as a whole' for the partner instead of agriculture. We add the base-year net output of the exchanges to that of everything else, and then calculate year-to-year movements without any reference to them. If we are only interested in producing index numbers, then we need not even compute their base-year net output.

This simplification of the task is so attractive that it is as well

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[1] Or private exchanges might be developed to replace the public ones.

to review once again the assumptions which justify it. Firstly, the service(s) in question must be essentially for the benefit of *industry*, not final consumers or the community as a whole. Secondly, the benefits must be of such a widespread kind that we cannot find a significantly better basis for allocating them between industries than in proportion to net output. And thirdly, the situation must be such that we shall not make a significant error by assuming the input of materials etc. into these services to move proportionately to output as a whole – the test of 'significance' depending, of course, both on the magnitude of the input and the possible error in the assumed movement.

V. GOVERNMENT 'FINAL' SERVICES

In this section I wish to make a few remarks about the government's output of services, which are not designed as assistance to producers, but rather as providing for the needs of final consumers or of the community as a whole. I do not pretend to have touched on more than a small part of the subject.

Perhaps the most important point is that in this field there is no escape from the fact that we must measure the year-to-year changes in the net output, and must do so in real terms. With the services assisting industry it was always possible to avoid measuring their gross output, because this was, *ex hypothesi*, part of the input into some other industry and so would cancel out on aggregation; and to a reasonable approximation we can usually avoid measuring their *input*, too, as explained above. But with final services this device is not available: the most we can say is that where the service falls into the class of 'regrettable necessities' (e.g. defence), one of the things we may want to do is to deduct the net output of the 'Armed Forces' industry (as well as its purchases of materials etc.) in order to arrive at a figure for the residue of the gross national product which is available for other purposes.

With some of these services it is very difficult to decide what the unit is in terms of which output should be measured, quite apart from the difficulty of actually doing it. The Armed Forces is perhaps the most difficult case, and a brief note of some of our attempts to grapple with this may be helpful.

We rejected the idea that the output of an army was zero,

either in peacetime or wartime: the element of truth underlying that concept seems to be met by our supplementary calculation of the total national product *less* the (gross) cost of regrettable necessities.

We also rejected any idea of measuring output in terms of the amount of training done, manoeuvres executed, etc. Apart from anything else this would imply that an experienced army which was (rightly) held to need less of this practice had a lower output than one made up of raw recruits. Looked at *ex post*, if the political weather had stayed fair this might seem plausible on the grounds that the only output was the increased (human) capital, but it does not take enough account of the army's main function of giving security.

We tried to conceive of an output as measured in terms of 'units of security' created, and became embroiled once more in the question whether to allow for changes in external circumstances – since the periods with large armies were usually those in which the feeling of security was at its lowest. There was also the problem whether to allow for reactions on the armies of potential enemies.

In the end we concluded that the right logical course was to visualize the sort of contract under which the services of the Armed Forces would be bought by the community if the 'industry' were run on a commercial basis. This seems right because the main body of the calculations relates to market phenomena, and the awkward parts should be made to conform as far as possible to the same general principles.

In applying this principle we have to recognize that the main objective of the purchaser would be to obtain immediate security, and that what he needs for this is mainly a stand-by service, in the same way as with a fire brigade. The contract may provide for *some* extra payment if fires are actually put out, but probably this would merely cover out-of-pocket expenses (and so not affect net output); essentially, the service provided is that of keeping a fire-fighting force of given size and efficiency 'on tap', and our job is to measure the size and efficiency of the force. Training and practice operations etc. can largely be ignored, except in so far as they are reflected in efficiency.

A further important point is that changes in the political climate would be things which affected the consumer's need for

this service, in the same way as changes in temperature affect his need for coal. If he reacts to these changes by placing larger orders with the industry, we want the figure for its output to rise as soon as the industry responds by keeping a larger force on tap. There is no paradox in recording a high output for the Armed Forces in unsettled times, even if no fighting has been done, and the output of security seems very low.

Two other points deserve mention. Firstly, it seems right to treat capital formation within the Armed Forces industry on much the same lines as in others. An increase in the stock of battleships is part of final output – but it will have been recorded elsewhere as the output of naval shipbuilding, steel production, etc., so does not require any entry under the Armed Forces industry. An increase in *human* capital, in the shape of trained men, is not normally counted as part of the output of an industry and so may be ignored here. (We can, however, soften the impact of this decision by counting the recruit under training as making a significant contribution to the effective size of the stand-by force.)

Secondly, in measuring the effective size of the stand-by force, and so the output of the industry, we ought clearly to allow for the stock of equipment as well as the number of men. The computational problems are very difficult, especially with laid-up and obsolescent ships, etc., but the principle is clear.

This section does not pretend to give concrete answers to specific problems of measurement. It is concerned with the necessary preliminary stage of seeing what concept we should be thinking of when we search for an (inevitably approximate) indicator.

VI. SOME NOTES ON MEASUREMENT PROBLEMS

This section makes even less claim to completeness than the one before. It is included mainly to enable me to stress the point which has impressed itself most firmly on all three of us: that although the logical order of exposition is to start by examining the concepts which one wants to measure, and then pass to the means of doing so, yet in practical applications the two processes are completely intertwined. The reaction of practicability and the nature of the data on objectives appears both in the overall design of the work – as we saw, for example, in the

discussion about changes in external circumstances and regrettable necessities – and also in the decisions about particular problems. On this latter point we may first note that it is seldom possible to measure changes in the *input* into the various industries, so that we usually have to fall back on the assumption that the volume of input moves proportionally to the volume of output. Even over a short period, however, there are two important cases where this assumption is unjustifiable, even as an approximation, and for these we have to arrange a different technique. The first is the very varying amounts of input of government services, which are likely to be *reduced* as the industry's output rises (e.g. with rationing); this problem is dodged by the methods described in Section IV. The second is the varying ratio of input to output in agriculture, owing to varying imports of feedingstuffs etc.; this problem is far worse if we treat the sections of agriculture separately, and we therefore deal with agriculture as a whole on the 'ring fence' principle, valuing the things which come out and the things which go in, all at base-year prices.

A few examples from particular industries may help to illustrate the problems which arise and to emphasize that the fundamental difficulty is to find indicators of year-to-year movements.

First there is the problem of the government services to industry, discussed above. Logically we can either treat the agricultural advisory service as a separate industry, or combine it with agriculture. Our industry breakdown would probably be more interesting if we treated them as separate industries, but each of the separate figures would be much less reliable than the combined one, and the process would involve more work. These considerations are decisive, so that in this case the nature of the data virtually determines the industry breakdown.

Secondly we get a similar problem with various private industries supplying intermediate services. The function of dealing in livestock or farm seeds for example is perhaps most naturally thought of as part of the distributive trades. But if we include them there we should need some indicator of the changes in the quantity handled, since clearly this activity of buying from one agriculturist to sell to another is not particularly correlated with the ordinary work of distributing consumer goods. This is a very difficult problem to solve, and so far as the aggregate is concerned it is all to no purpose; for the services of these inter-

mediaries aie an input item to the agricultural industry (which we take as a single unit), so that the volume used in each year must be subtracted there. It is far simpler, therefore, to merge these dealers with agriculture and measure the output and input into the combined industry in each year.

A third way in which the computational or measurement problems may be simplified by a suitable definition of 'industries' may be seen from the case of the accountancy profession. The 'natural' definition of industries would treat this as a separate industry, to be included in the sub-group of professional services. That procedure would, however, involve several difficult operations, including:

(a) Computing a weight (base-year net output) for the accountancy industry.

(b) Devising indicators for measuring year-to-year changes in the volume of work done by it.

(c) Ensuring that the base-year net outputs of other industries were arrived at *after* deducting payments for accountancy services.

(d) Allowing for year-to-year changes in the amount of accountancy purchased per unit of output in all other industries (since for most of these the basic indicator will relate to gross output, which will be assumed to bear a constant ratio to net output – a particularly doubtful assumption for accountancy when industries are being nationalized and perhaps relying more on internal auditors).

These problems can be largely avoided by a device similar to that used with government services to industry in general. Virtually all the (gross) output of the accountancy industry is input into some other industry, and would therefore cancel out on aggregation, so that its movements (or lack thereof) ought not to have any direct effect on the final aggregate.[1] We ought, strictly speaking, to take account of movements in its *input* in the same way as with the employment exchanges, but this is a quantitatively unimportant point. In effect, therefore, we can dispose of the problem by defining each 'industry' as including not only its ordinary activity, but also whatever accountancy it uses – whether provided internally or bought from outside.

[1] As with government services, the *indirect* effects are reflected in the output of other industries.

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The weight is increased to cover the accountancy (or, in many cases, not reduced to get rid of it), and the output of each 'enlarged' industry is measured by the same indicators as would be used for the industry proper. The paper etc. bought for the accountancy section is assumed to move proportionally with the gross output in the same way as other input items – not a very accurate assumption, but a very unimportant one.

Yet another instance in which the nature of the available indicators determines the procedure may be seen from the case of H.M. Stationery Office. We were just about to debate which of various approaches to adopt for this when we realized that our indicator for the general printing etc. trade and thé manufactured stationery trade taken together was to be the consumption of printing and writing paper (other than newsprint). Since the consumption by H.M. Stationery Office was inextricably mixed with that by private firms we had in fact no option but to regard it as part of this composite industry – a very reasonable treatment, since its functions are broadly similar – and regard the other government departments as purchasing its output of printed forms etc.

Perhaps I might conclude this list of examples with one in which the nature of the available indicators will probably cause us to split a part off one industry and attach it to another. This treatment will probably be necessary in dealing with the distributive trades, which own a considerable number of lorries, vans, etc., which they use both for delivering goods to their customers and for collecting some of their incoming supplies. The ordinary 'industrial' approach would treat the operation of these vehicles as part of the distributive trades, and their drivers are classified in those trades. In our case, however, the data which we can use as indicators for the industry of 'goods transport by road' (number of goods vehicles on the road, petrol consumed, etc.) all relate to the *total* activity of transporting goods, whether it is done by the road haulage industry proper or by traders operating their own vehicles. Moreover, on the other side our information about movements in the volume of goods handled by the distributive trades does not distinguish between goods delivered to customers and those taken away, nor yet between those collected by them in their own lorries and those sent to them by public transport of some kind (or by the manufacturers' lorries). In effect, therefore, we

have no option but to regard the work of the distributive trades as divided into two portions – 'distribution proper' and 'delivery (or collection)' – and add the latter to the road haulage industry. Strictly speaking the latter will, indeed, have gathered to itself the transport of goods by producers as well as by distributors: our approach is necessarily a 'functional' one, measuring changes in the amount of certain functions performed (manufacture, transport by road or rail, other distributive services) rather than in the net output of certain groups of establishments.

The above example is typical of the general point that the information available is suitable for measuring changes in the volume of certain activities, no matter who performs them, rather than in the activity of the establishments which are classified to a certain industry. The same thing is usually true with an ordinary index of industrial production; but the problem is much more acute when the index is extended to cover the whole economy, because the various functions are performed in so many alternative and overlapping ways. There is a much less clear-cut division of establishments between the various 'service' industries, and a correspondingly looser connexion between movements in the volume of certain functions performed and those in the net output of the establishments in the most nearly corresponding industry.

In itself, the fact that our statistics relate to certain functions or operations rather than to groups of establishments is probably an advantage rather than a disadvantage: they relate more nearly to industries as we would *like* to have them, if it were not for the awkward fact that establishments insist on carrying out overlapping functions. It means, however, that comparisons between many of the group index-numbers and movements in apparently corresponding employment statistics are of very limited value.

VII. CONCLUSIONS

The conclusions of this paper have already emerged in the different sections, but it may be convenient to summarize some of the main features of the treatment proposed here and link these up with other strands of thought in national income methodology.

1. The object of the investigation described is to deflate the gross geographical product at factor cost. This means that the

total weight to be apportioned among the different indicators is the total of factor costs (including profit) and depreciation provisions all defined in the generally accepted way. Our treatment of specific problems, and particularly of government services, does not involve any departure from the ordinary measure of the value of the gross geographical product at factor cost, but only a reapportionment of this total between the different branches of activity.

2. The general point of view is essentially that of Geary (op. cit.), in which to measure changes in net output we need in principle indicators of output and also indicators of input. From this it can be seen that since in the aggregate all intermediate products will cancel out, the approach adopted here will in principle be identical with one which aims to reduce final expenditures (measured at factor cost) to terms of constant prices. (To secure this agreement between the two approaches final expenditures must, of course, be defined to exclude those purchases of goods and services by the government which were used to provide assistance to industry, adopting the same definition as in the other approach; and the corresponding 'subsidies in kind' must be allowed for in making the measurements at factor cost.)

3. We take the world as we find it and do not attempt to attach praise or blame for what actually happens, nor, in measuring real product, do we attempt to decide whether or not individuals or the community 'really' want some of the services which in fact get provided. It is recognized, however, that the product total, viewed as a measure of real final expenditure, may for some purposes need to have subtracted from it certain subgroups of expenditure such as expenditure on maintaining the armed services.

4. The problems considered have been discussed in terms of the state of affairs in the United Kingdom at the present time. An attempt has therefore been made all along to deal with government services in such a way that we may pass from periods of control and back again without distortion. This involves a smudging of the line between private and government activity at many points, but it is thought that the industry groupings which result from our suggestions are in fact more appropriate to contemporary conditions than those which would result from an attempt to keep the two forms of activity separate at every point.