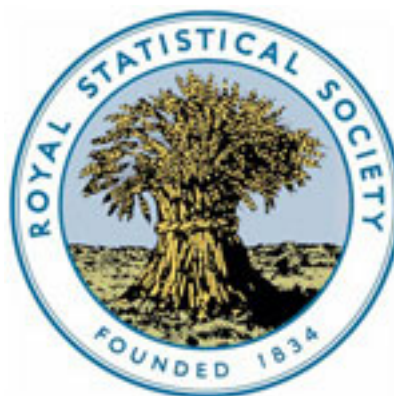


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MARCH, 1921.

THE MEASUREMENT OF PRICE CHANGES

By A. W. FLUX, C.B., M.A.

[Read before the Royal Statistical Society, January 18, 1921,
the President, Sir R. HENRY REW, K.C.B., in the Chair.]

OUR Society has a traditional interest in price index-numbers, and no excuse is needed for bringing the subject before you again, in view of the extremely violent changes in the purchasing power of money which have resulted from war conditions. It is unnecessary to attempt any historical survey of the occasions on which important communications on the subject have been laid before the Society and I do not propose to emulate the example of our American colleague, Mr. Wesley C. Mitchell, who has comparatively recently surveyed the actual and possible ways of preparing index-numbers of prices. It is sufficient to recall that it was in our *Journal*, of which he was then Editor, that Newmarch, in 1860, presented the records and calculations which later resulted in the establishment of the *Economist* index-number, that Jevons developed his index-number in a paper read before our Society in May, 1865, that Mr. Sauerbeck introduced his index calculations in a paper read here in 1886 and communicated in a series of annual memoranda the later figures of his series, and that Giffen expounded to this same Society in January, 1879, the methods by which he measured the changes in import and export prices. It is a consequence of the work of these eminent fellows of the Royal Statistical Society that I propose to venture to-night on some critical discussion of the problem and to explain the procedure which it is proposed to adopt in a new series of index-numbers of wholesale prices to replace the existing Board of Trade index-number. The difficulties which

were encountered in securing, in 1918, the usual annual record of the Sauerbeck figures were the final stimulus which led me to place on the list of future papers the title of to-night's communication.

For myself, as for the Society, the subject under discussion to-night is not a new one, and, as indicating the development of some of the points to which I propose to invite your attention, I may be allowed to refer to a paper communicated to the Manchester Literary and Philosophical Society in 1897, in which I examined the effect of changing the base-year for such calculations as those of the *Economist* and of Mr. Sauerbeck, and to a paper which appeared ten years later in the *Harvard Quarterly Journal of Economics*, in which the subject was further developed, and what has come to be known as the "chain" method of compilation, to which I shall refer at greater length presently, was tested by a practical example (see Appendix III), while the bases of various well-known index calculations were briefly examined and some of their defects were indicated. I refer to these papers to make it clear that, in taking up the main points of to-night's discourse, I am not simply selecting from recent literature and appropriating ideas from the admirable surveys which have rendered it superfluous for me to attempt any systematic historical or analytical summary of what has actually been accomplished and the possible alternatives among which the choice of the statistician in this field of work lies.

During the year 1920 attention has tended to be drawn to the degree in which different indices of price movement differ in their indications rather than to their general consilience. Among the index-numbers compiled in the United States, that of *Bradstreet's* reached its maximum in the figure recorded for February 1, and in the following ten months it fell by more than one-third to about the level of four years earlier. The indices compiled by the Bureau of Labor and by the Federal Reserve Board showed an advance in the price level continued till May, and the subsequent decline carried the figures about to the level of two years previously. In this country the turn of the tide is indicated as occurring in March or April by the index calculations of the *Economist*, the *Statist*, and *The Times*, while the Board of Trade index-number, after a slight setback in April and May, reached its highest point in July. The reaction in prices of industrial materials set in earlier than that in foodstuffs, and this is an important reason for the movements of the latter index. The movement shown by the *Statist* number (the Sauerbeck index) has lagged behind that shown by the *Economist* number, though only by about a month. Both in respect of the time at which the highest level of prices was attained and in

the measure of the reaction that succeeded, the different indications afforded by existing index-numbers, both in the United States and in this country, have not been in agreement. With changes of such a marked character in progress, that section of the public which looks to these index-numbers as a simple and infallible expression of the course of prices has experienced some confusion. (*cf.* Appendix I.)

A brief examination of some of the characteristic features of the different index-numbers may indicate the main causes of their divergent indications at such a time as the present.

The range and nature of the price-records.

The British index-numbers are all dependent on a comparatively narrow range of price-records. The *Economist* number, based on the prices of 22 commodities, extended the range of prices to 44 commodities when readjusting its reference period some ten years ago. The Sauerbeck number, covering 45 series of commodity indices, uses actually 57 series of quotations. It is not quite clear from the recently published records how far the *Economist* follows the same practice of averaging two, or even three, quotations to secure a single commodity index. In the cases of beef and mutton, at least, the averages of two quotations are used. The *Times* compilation rests on 40 price-series and the Board of Trade number covers 47 articles or groups of articles. In the last case a majority of the data are not prices in the ordinary sense, but average declared values of goods imported into or exported from the United Kingdom. In 35 cases import values are taken and in four cases export values. The foreign trade values do not, like the market prices used generally in other index-numbers, relate to a defined grade or standard quality of the article in question, but represent the average of all the grades or qualities occurring in the imports or exports recorded in the period concerned. This tends to stability, and it also tends to make the prices represent the grades actually available for use, so that the price-variations may reflect not only changes in the intensity of demand, but changes in the qualities of goods available. How far this is a disadvantage depends somewhat on the aim of the compilation. A more serious point is that the values reflect rather the terms of contracts concluded an unknown number of months ago than the position of prices resulting from current supplies and current demand. This consideration may probably contribute to the explanation of the divergent indications as to the period when prices reached their highest point in 1920.

While there may be some advantage in following the prices of the goods actually available rather than those of standard qualities which may not reflect the general market position with equal precision at all times, and while, at ordinary times, the tendency to lag behind the movements of the markets may be of little importance, a period of extraordinarily violent changes tends to throw up the disadvantages of using average declared values of imports and exports as indications of fluctuations in market values. It is, however, to be noted that, while the private enquirer or critic can examine for himself the details and can construct for himself the numbers for any period if they are not officially published or the record is not accessible, this is unfortunately not the case with the *Economist* and *Statist* numbers. Only when the annual survey is published in each case do the separate price data become available, and the sources used are not recorded with sufficient precision to afford the enquirer a means of doing for himself more than the compilers choose to do for him. The importance of this can be illustrated by the difficulty of tracing the precise relations of *The Times* index-number to these older numbers compiled in a fashion generally similar. An examination of the course of prices of the articles common to the *Economist* and *The Times* series showed a divergence in the calculated average changes which must be traced to the nature and sources of the prices used, but could not be readily submitted to the examination which its interest invited for lack of precise and adequate indications of the sources of the quotations. It would be very easy to correct this defect, and I venture to suggest to the responsible authorities that they should take this reform of a detail in their procedure into careful consideration. Neither of the two best-known price indices can be currently examined in detail at present except at the offices of the newspapers which are responsible for them. The annual survey of the *Economist* index appears promptly after the close of the year, but the data of individual prices have not hitherto been given exhaustively. I understand that the omission of two of the articles from the tables issued last year does not represent a policy deliberately adopted, and is likely to be made good this year. The *Statist* survey has normally appeared in the March number of our *Journal* as in the days when Mr. Sauerbeck was personally concerned in its preparation. Even this means that the only opportunity for careful detailed examination comes rather long after the interest in the data has culminated, and when, as in 1920, the survey next in sequence to that of March, 1918, was not available till July, 1920, the treatment of the student of prices appears to lack something of frankness. He is offered a

monthly result of calculations which he is almost excluded from utilising in any form other than that in which it is published, *i.e.*, ordinarily, with separate figures for foodstuffs and industrial materials, and for the main sub-groups but not for individual articles. The particulars furnished in the annual article in our *Journal* do not enable the precise quotations used to be identified, so that only the compilers can prepare figures for any period not specified in the annual articles.

It is unnecessary to enter with as much particularity on the detail of the American numbers as on that of the English numbers. The compilations of *Bradstreet's* cover about 100 commodities (the number has varied somewhat from time to time), for which the quotations are supplied monthly when the results of the compilation are printed. It would appear that 96 prices are used in the calculation of the index-number. For the index-number of the Bureau of Labor Statistics, the number of different price-series has also varied from time to time. For 1890 the number was 251, in 1897 it had reached 261, and in 1913 was 252. In 1914 the method of compilation was revised and the number of items included increased. At the present time the number is 328. The sources of the quotations are in some cases precisely stated in the series of official bulletins devoted to the subject. In a large number of cases, however, the prices are specially obtained from manufacturers and others. The Federal Reserve Board bulletin gives the results of the calculations on which the index-number prepared for the Board is based grouped in various ways. The detailed particulars are not specified. The number of commodities covered is 90.

Method of combining results.

All the numbers to which reference is made in the preceding paragraph represent arithmetic averages of the separate price-series used. All except the Board of Trade index for this country are simple arithmetic averages of the separate price-indices. In the case of the Board of Trade number weights are assigned to the several articles whose prices are used, and the resultant index is a weighted arithmetic average. The detail of the weights is given in the buff-book No. 321 of 1903, bearing the title "Wholesale and Retail Prices," and in the issues of the Abstract of Labour Statistics, in which the details are shown. The weighting of *Bradstreet's* number is accomplished by taking the price in cents of a pound weight of each of the commodities, compiling group averages for 13 groups in which they are arranged, and adding the

13 group figures to produce the final number. It is not quite clear how certain of the articles are treated in reaching the group averages, since the full effect is not found of the obvious influence of articles bearing an exceptionally high value. It would appear that a number of the prices quoted are not used in the calculation of the index-number. It is clear that, for most if not all the purposes of measurement of average prices, an increase in the price of silk is of less importance than a similar increase in wool or in cotton. Even the inclusion of yarn and piece-goods of cotton in addition to the fibre is unlikely to effect an adequate adjustment. Similarly silver and quicksilver would appear to have an influence on the index entirely incommensurate with their industrial or commercial importance relative to iron or copper. Some means of evading the difficulty in part appears to be adopted, but if this is the case, the precise procedure is not explained in any of the articles in which it would be naturally sought.

Bradstreet's index-number, by its nature, does not depend on a base-year from which the calculations start. All the other numbers named are arranged so that the price of each commodity is expressed as a percentage of its price at a selected date or in a selected year or period of years. The percentage numbers are added (after multiplication by the numbers expressing the weights assigned to the several articles in the case of the Board of Trade number) and their average forms the aggregate index-number.

The index-number of the Bureau of Labor Statistics was, prior to the war, calculated as a simple arithmetic average of prices expressed as percentages of the mean prices of the decennium 1890-99. Beginning with the calculations for 1914, in addition to including an extended range of price quotations, the individual prices have been weighted in proportion to the estimated quantities of the commodities to which they relate which were marketed in the year 1909, the total being distributed between the centres for which quotations are secured in proportion to the importance of those centres as markets. The result obtained is thus an aggregate value of all the goods (in 1909 quantities) in each month or year for which the prices are obtained and the calculation is made. Each of the three annual reports which have appeared has expressed the series of numbers as percentages of those of the latest year covered by the report. Thus the reference year is varied with each annual survey. In the "Monthly Labor Review" the new series of index-numbers are shown for each of the nine principal groups of commodities, as percentages of the numbers relating to 1913. The actual prices used are recorded for 70 of the principal commodities.

In the case of the *Economist* the original base-period was 1845–50. As already stated, the series of quotations underwent some revision in 1911, when it was found possible to re-start the calculations from the base-period 1901–05 without affecting the aggregate index-number. Mr. Sauerbeck used the eleven years 1867–77 as the base-period for his calculations and it remains unchanged to-day. In the half century that has elapsed various changes have occurred which have as their result that the maintenance of the old base-period affects the relative importance of variations in prices of different articles so as to make them unequal when they were originally assigned equality, and *vice versa*. Examples are easily found in any index-number of this type. Thus, in the Sauerbeck index tin and copper are assigned equal importance. But both in 1913 and in 1919 tin had an index-number double that of copper, its variation from the price of the base-period having been so different from that of copper as to produce this result. Thus while the price-change between 1913 and 1919 was in the same proportion for the two metals, this advance added 32 points to the aggregate index-figure in the case of copper and 64 in the case of tin. What had been intended to be equal importance had become markedly unequal. Illustrations need not be multiplied to enforce a principle so obvious.

The so-called unweighted index-numbers calculated as arithmetic averages are, in fact, weighted index-numbers, expressing the cost at any date of those quantities of the commodities for which prices are used in the index-number, which, at the reference date, were purchasable for 100 units of money, say 100*l*. Thus the change of the base-year of the calculation involves the substitution of a new series of quantities, and accordingly the index-number furnishes indications of price movement correspondingly different.

Reversibility.

A consequence of the relations now under consideration is that the indications of the extent of price-variations depend to a far from negligible extent on the selection of the base-year or base-period. If we calculate for any series of years two index-numbers from the same price-data, using the initial and final years of the period as base-years in turn, it is generally true that the measure of price-change over the period is not identical by the two methods.

A special and noteworthy illustration of this is afforded by the Board of Trade index-number, originally based on the year 1871 and later revised so as to make 1900 the base-year. According to the original calculations, the average price-level of 1871 was 20

per cent. higher than that of 1900, the index-number for 1900, calculated from 1871 as base-year, being 83.2 . The result of taking 1900 as base-year was to show for 1871 an index-number of 136 . Even over a period of thirty years the difference cannot be treated as negligible.

In this case, the divergence might have been avoided by adjusting the weights assigned to the different articles. Broadly speaking, the group of coal and metals showed an advance in price of 50 per cent. while the remaining groups showed a fall of about 25 per cent. Thus the former group had about double the relative importance in the original calculations for 1900 to that which it received in the revised calculations for the same year. This is by no means the whole of the difference, but it is the most prominent feature, and its adjustment alone would remedy two-fifths of the divergence between the relative levels of 1871 and 1900 as measured by the two calculations.

There is only one certain way of ensuring that the selection of the base-year shall not influence the measure of price-change secured, and that is to make the calculations every year with the preceding year as base-year and link up the results. This procedure has been given the name of the "chain" method in American discussions. If the more usual method be adopted, an adjustment becomes necessary from time to time, say each tenth year. The calculations being started afresh each decade, it will be found that, if calculations be made backwards as well as forwards, the period covered by the double calculation has its characteristics expressed in two more or less different series of numbers. If such violent price-changes as have been recorded in the last ten years are in question, the two calculations may possibly yield results with serious differences.

As an example of such differences, we may take the Sauerbeck figures for the year 1919 and for the decade 1904-13, immediately preceding the war. The index-number for 1919 was 269 per cent. of the average of the indices of the ten-year period and, if that period be taken as the base-period, the index for 1919 works out at 270. This close correspondence suggests that any changes of the nature of those previously referred to have, on balance, practically cancelled out. But if we take 1919 as the base-year, the relative prices for 1904-13 work out at 40.0 per cent. of those of 1919, so that the figure 250 expresses the relation of 1919 prices to those of 1904-13 calculated from 1919 as base. The difference between 250 and 270 expresses the effect of inverting the order of the calculations. And as there is no special reason for believing that it is more proper to

calculate forward from a base-year or period rather than forward to a base-year or period, the ordinary procedure leaves us uncertain as to the proper measure of the price-change. The example of the Board of Trade index-number does not stand alone as an illustration of an effect which can only fail to appear by a combination of favourable accidents.

The objective sought.

In the article in the *Quarterly Journal of Economics* to which I have referred, I pointed out that there are two important questions to which one might expect to find the answer in the indications of a well devised and carefully kept index-number. The one is "What is the change in the money-cost of the things we buy due to price-changes since any given date in the past?" The second is, "What is the average change in the value of money relative to other things since any given date in the past?" (*loc. cit.*, August, 1907, p. 620).

The difference which I then tried to express has of course been discussed by other writers. At the present time I should be disposed to express the two conceptions somewhat differently. The first relates to the point of view towards price-changes of the manager of the household expenditure. The answer to it is to be found quite naturally in the comparative money cost of a fixed schedule of articles at different times. The amount of the several commodities determines the importance of their price-changes in the aggregate measure of price-change. An index-number, calculated on the lines of a weighted arithmetic average, with prices expressed as percentages of those of a period selected as the reference period, is the natural method of calculating the measure of change. For retail prices no other procedure is likely to commend itself as obviously appropriate. How far the same conception may be deemed appropriate in reference to wholesale prices is, however, a matter for consideration and argument.

What has been said above as to the different results obtained by changing the reference period need not apply to the weighted arithmetic average procedure in calculating an index-number. Expenditure weights applied to price-ratios give but a variation in arithmetical procedure in calculating from quantity weights and absolute prices. But a clear recognition of this point leads to the conclusion that, proceeding by expenditure weights and price-ratios, the change of the base-year, if not accompanied by an appropriate change of weights, furnishes us with a new index-number. The change of base of the Board of Trade index-number

is an illustration of this already sufficiently emphasized. In that number the weights used were proportional to the estimated expenditures, in the decade 1881-90, on the classes of goods whose price-changes were reflected in the prices of the commodities selected for quotation. The example of an eminent official of the Department seemed to justify the procedure,¹ and doubtless, in changing from the base-year 1871 to the base-year 1900, the weighting derived from the period 1881-90 seemed as appropriate in the one case as in the other. Yet in neither case did it yield figures of expenditure corresponding to the base-year unless we can accept the hypothesis that quantities used varied inversely with current prices. In any case, looking at the weighting as reflecting a series of quantities, a quantity budget of the nation so to speak, the quantities which lay behind the estimated expenditure of 1881-90 were different from the quantities which the weighting appears to assume as the foundation of the calculation from 1871 as base-year and different again from the quantities appropriate to the identical expenditure weights applied to 1900 as base-year. The change of base-year, though apparently made without changing the weights assigned to the several items in the calculation, actually had the same effect as setting up a new series of weights. It cannot be said that the weights used were less appropriate to 1900 than to 1871, but it is clear that, however true it may be that the weighting of an index-number may vary within a not inconsiderable range without seriously affecting the results reached, substantial changes of weighting leave behind themselves substantial effects on the index-number.

When the quantities which are reflected in an expenditure weighting remain invariable the weighted arithmetic average yields an index-number which is unaffected by the date from which the calculations start. In effect, we calculate for any date the money cost of a specified list of goods, with specified amounts of the several commodities, and compare the total expenditures. The *Bradstreet* index-number is a somewhat extreme example of the type, in taking a pound weight of each commodity quoted, and using several quotations of allied articles, or of varieties of the same article, to afford adequate representation to the more important groups of commodities. The new calculation of the Bureau of Labor Statistics is a careful and elaborate example of the same type.

¹ Reference is here intended to Sir Robert Giffen's procedure in calculating the price-movements in Import and Export trade, when he took 1861 as the base-year for prices and 1875 as the year the trade of which furnished the relative importance of the several commodities. Some of the results were presented as percentages in which the figure for 1883 was made 100.

It appears to me, however, to say the least, doubtful whether this conception is entirely appropriate to the case of wholesale prices. While in retail dealings the point of view of the householder, spending the bulk of his income week by week on the purchase of current supplies, makes the money valuation of an average week's expenditure the appropriate measure of the effects of price-changes on his financial position, the money valuation of all the things bought by a community is not quite so clearly the measure of the effects of changes in money prices on its financial stability. We do not, in effect, as a nation, go into the market and purchase the supplies we need in the same sense as does the private citizen. An index of retail prices has only a limited application to groups of persons who depend on their own exertions for a large part of their material satisfactions, and purchase only the things not obtainable as the fruit of their direct labour, and we should not seek to measure by an index-number of retail prices, based on a complete budget of family requirements, the effect of price movements on such groups. The importance of prices to them is related to what they sell of their own produce and what they buy with the proceeds, not on the market cost of the commodities consumed. The determination of appropriate weights for wholesale price indices has always been a problem involving a choice between conflicting conceptions. In our own case a striking example is afforded by the case of cotton, which only illustrates, however, the conditions found in numerous other instances. What weight should we assign to the price variations of cotton and of cotton goods in our calculations? Should it correspond to our national consumption for personal, domestic and the like purposes of cotton and articles of cotton, or should it correspond to our interest as a manufacturing community in cotton as the principal raw material of one of our greatest industries and a subsidiary material in various others? Generally speaking the conflict between these two claims has led to a compromise, more or less unsatisfactory of necessity. If we adhere to the budget view as to the proper object of measurement in compiling our index-number, we cannot escape the difficulty.

The alternative conception is by no means free from difficulties of the same class, but it may be found that they have less fundamental importance or can be solved with a closer approach to exactitude. That conception appears to me to be that we desire to ascertain, in reference to wholesale prices, what is the extent of the influence of the general economic position on all prices. Each market is subject to special influences and conditions, dependent on the manner in which the supplies of the commodity concerned are

varying or likely to vary and the manner in which the demand for the commodity responds to price-variations. But conditions of currency and credit, and of the general economic situation so far as these are not reflected in credit and currency, affect all wholesale markets, and it is the net effect of these general conditions which appears to be the appropriate aim of the makers of wholesale price indices.

Each individual commodity reflects the general conditions, the effects of which are modified by the special conditions of that commodity. The process of averaging to be adopted must aim at eliminating the effects of such special conditions. A suitably weighted arithmetic average might effect the purpose, but the problem of determining the appropriate weights is of exceptional difficulty. The consumption basis, either consumption by ultimate users of finished products or consumption of materials by makers of manufactures for export as well as for home use, will not be very obviously appropriate. The frequency of exchange of commodities forms one of the elements to be considered, as Professor Irving Fisher has insisted. But the measurement of that frequency and the ascertainment of its variations presents difficulties not readily overcome, and in respect to which divergence of opinion may exist, which would cast some doubt on the soundness of the results in which the estimate of frequency of turnover (rapidity of circulation) exercised an important influence.

The analogy of the procedure of physical or chemical investigators seems not inappropriate. When a series of measurements of an object are made, the errors of the instruments and of the observers have to be eliminated by averaging the records in a suitable manner. Each measurement or experiment is, as it were, a shot at a target, and though it miss the bull's-eye, if there be a sufficiency of shots and no reason (such as wind) to throw them predominantly in one direction rather than another, the position of the centre of the target, the aim of all the shots, if not known can be deduced with considerable accuracy, or, if a wind be blowing, its strength can be very closely gauged if the position of the bull's-eye be known. May we not treat the relation of the price of any commodity to its own level at a selected date, or over a selected period, as something the measure of which is a shot at the measure of the general currency and economic drift so far as it relates to prices? When a commodity is of great importance in our economic life, its price-position should have an influence on the index-number such as many shots from the same rifle might have in the case of the target.

We have, indeed, a number of individual shots and a number of

groups of shots, from which to deduce the position which all would have shown had there been no causes peculiar to the individuals or to the groups tending to deflect the shots from their aim. The size of any group—i.e., the number of shots comprised in it—will be proportionate to the importance of the market conditions affecting the commodity whose price-variations correspond to the positions of the group-shots. Clearly no large degree of importance need be assigned to the precise adjustment of the number of shots in each group. Only if shots omitted or included through failure of precise adjustment were such as showed very substantial deviation from the groups to which they belonged could one or two shots less or more affect the position of the point aimed at, deduced from a really considerable number of positions marked on the target.

If this point of view of the purpose and possibilities of an index-number of wholesale prices be admitted as of at least as great importance as the ideas underlying the budget conception, then the selection of the method to be employed in averaging need not be biased by the preconceptions connected with the family expenditure view of the effects and importance of price-changes.

The use of the geometric method of averaging, though not generally regarded as equally simple with the arithmetic method, is in reality not a whit more abstruse in conception and in practice hardly more complicated when once it has become familiar. It has the advantage of minimising the effects of wild shots, if I may so designate the results of exceptional variations in individual prices. If the other advantages of making each year's calculations so that their primary aim is to measure the deviation from the preceding year's position be conceded, the use of the geometric average falls in naturally with the obvious method of compounding the yearly variations so as to give a series of figures tracing historically the price-variations of a series of years. Where the elements to be operated on are the ratios of prices to those of some standard position, a geometric compounding of those ratios is as naturally suggested as would be, in the case of variations measured by absolute differences from a level selected for comparison, the arithmetic method. It is a somewhat remarkable phenomenon that, operating with price-ratios as has been usual in this country, the use of arithmetic averages of those ratios has been so general. The procedure adopted by Jevons, of using a geometric mean of the price-ratios, appears to be more consistent, to manifest a more natural association of ideas, than that of most other practical workers in this field.

The "step by step" or "chain" method.

The advantages of employing the chain method of calculating price index-numbers are by no means negligible. The problem of keeping the index in touch with changing conditions solves itself with great ease in this case. A new commodity, or one newly arrived at a position of importance, can be introduced at any time without confusing the entire series of calculations. It is only necessary to secure a satisfactory price comparison with the preceding year in order to fit a new quotation into the scheme. Similarly outworn commodities, if and when they occur, can be dropped, a quotation once representative but no longer a safe measure of the market position can be replaced by another better suited to its purpose, and, in the case of seasonal articles, if different varieties are actually the subject of active commercial transactions in the course of the year, there is no reason why a monthly index-number should include a nominal quotation of a commodity in some months when an active quotation of a closely analogous commodity can be secured for those months but not for the whole year.

The hampering effects of using a reference period were felt before the war in the preparation of the Board of Trade estimates of the values of imports and exports at the prices of 1900. Commodities for which the requirements in force in 1900 provided no record of quantities imported or exported remained the subject of estimate so long as the procedure of direct calculation was adhered to. Further, the field of applicability of direct calculation was constantly being narrowed by changes in the classification, and the increased knowledge, and possibilities of improved accuracy in the results, which the increase of detail furnished placed at our disposal, was not utilizable while this procedure was maintained. The latest of the series of calculations for which the results were published before the war abandoned the method of direct comparison with 1900, and substituted the method adopted throughout the series of calculations made by the *Economist* regarding the variation in volume of our foreign trade, namely the year-by-year comparison, the yearly links being welded together to form a chain by an obvious and familiar procedure.

The new Board of Trade index-number.

The index-number calculated since the year 1903 at the Board of Trade, and based on the principles already explained in the course of this Paper, has been calculated for a period beginning with 1871 and ending with 1920. However well adapted it may have been

to the conditions of part of that period it would be strange if the changes of half a century were such as to make it equally suitable throughout that long period and left it still suited to the conditions of to-day, with all the changes produced by the war and its consequences. Only one change has been made since the initiation of the calculations other than the change of base-year, and that is the use of separate price figures for butter, cheese and milk, instead of one price for the three as a group. Some reconsideration of the basis of the calculations was essential. The example of the *Economist*, which rejuvenated its index-number when the base-period lay half a century in the past and started afresh with considerable changes of detail in spite of a large degree of formal adhesion to the old routine, may serve to illustrate how this need of overhauling affects index-numbers of prices, as it affects material structures and systems of administration, &c.

As revision is necessary, advantage is being taken of the opportunity to vary the method of calculation. The multiplication of calculations of one and the same type appears to present no serious advantage. With the *Economist*, the *Statist* and *The Times* all compiling index-numbers on the principle of the arithmetic average, the possible differences in results from variation of material can be quite adequately studied. The special feature of the Board of Trade index, that it utilized average import and export values in place of market prices, has, owing to the extraordinary situation created as the outcome of conditions resulting from the war, rendered the indications of the number remote from the actual current facts which it should reflect. It is, accordingly, proposed to use market prices as the basis of the future calculations, thus destroying one of the important points of difference between the official and the unofficial calculations. The remaining point of difference, the weighting, presents problems capable of solution in more than one fashion, and, as has been pointed out earlier in this Paper, the adaptation of the weighting to changing conditions, even the satisfactory determination of appropriate weights for any date, is a problem which does not appear to possess a unique solution, when the method of arithmetic averages is used, and with that method the weighting is apt to be too important in its effects for a large uncertainty in the weights to be readily acceptable, even as a provisional solution in default of a better.

It is intended to compute the new Board of Trade index-number by the geometric method, *i.e.*, the indices for individual commodities will be taken and their geometric mean will form the index-number for all commodities.

At the same time it is intended to extend the range of the articles quoted, and to use different quotations of closely similar commodities instead of giving to the price-variations of one commodity of such a group an importance proportional to that of the group. An advantage of this is that, so far as the conditions affecting price-variation are not identical for all grades of wheat, for example, the risk of multiplying the peculiarities of one particular grade of wheat, and treating all wheat as if it shared those peculiarities, is decreased. To some extent the market conditions of different varieties of wheat (or of iron, or coal, or leather or anything else) are not identical. Weighting by this method is merely pushing further a principle accepted in some of the well-known index-numbers. It cannot be adapted to weights calculated with much precision unless the whole number of quotations used is inordinately increased. But if the number of quotations is not too small, fairly satisfactory weighting can be secured in this way. If the appropriate weights are subject to great dubiety, less mischief results from the proposed procedure than from the application of dubious weights in the "budget" procedure.

The grouping of the quotations.

Following on the completion of the First Census of Production, which for the first time enabled a complete survey to be made of the relative importance in the industries of the country, and in its consumption, of the different groups of commodities, a calculation was made of the modifications which the new information appeared to justify in the weighting of the index-number as it then stood. For various reasons the substitution of the new weights for the old was deferred. Had the normal procedure in connection with the Second Census not been interrupted by the war, the confirmation or correction of the new estimates of weights might have led to a revision, and to the establishment of a system of periodic reconsideration of the weights as the results of each successive Census of Production became available. The larger changes now to be adopted may facilitate such periodic adjustment of the index to changing conditions. Though the results of the enquiry as to production in 1912 are not yet complete, it appears probable that no very marked divergence from the standards indicated by the First Census will result, and accordingly the arrangement now to be introduced, based on the First Census, is considered to be justified as a provisional measure pending the ascertainment of the position after the war. The relative importance of the different series of prices is shown in Appendix II, which gives the results of calculations made in the Statistical Department of the Board of Trade. The figures are

based on the value of goods manufactured for consumption within the country or for export, together with the imports of goods which pass into consumption without undergoing a preliminary process of manufacture after importation. The preparation of goods by the users, as in the case of foodstuffs prepared and cooked in hotels, restaurants or private houses, is not treated as manufacture for the purpose of these calculations.

In all, it is proposed to use 150 series of price quotations, divided into eight groups of approximately equal importance. In a few cases the variations of a series of quotations are to be calculated, not from the prices of one selected commodity, but from two or more price-series, a procedure common in existing index-numbers, of which the annual articles in our *Journal* showing the detail of the Sauerbeck index furnish examples that will be familiar to the student of the subject.

Three of the eight groups consist of foodstuffs, the individual groups comprising respectively, (1) cereals, (2) meat, poultry and fish, and (3) other foodstuffs. The industrial materials and products are divided into five groups, the usual metals and minerals group being divided so that the dominant importance of iron and steel is recognized by assigning to the prices of these commodities a group to themselves. Similarly the textiles are subdivided and cotton and its products form an entire group, while other textiles form a distinct group. A miscellaneous group is made up of chemicals, leather, timber, paper, &c.

It is proposed to compute the indices for the several groups and to combine the eight groups on a footing of equality of importance, ignoring the variations in importance between the groups.¹

Within the groups the quotations to be used are distributed in approximate proportion to the importance of the commodities themselves. A point of importance in some cases is that, to avoid the duplication of weights where the list includes, sometimes in different groups, materials and goods in the manufacture of which they are used, the weights thus carried forward are omitted from the earlier stage. The important cases are those of coal and maize. As a feeding material, the latter article influences the supply and price of meat and the weight assigned to it is exclusive of the importance which it possesses in this connection. The case of coal is similar, but its absorption in the value of goods in whose manufacture it

¹ The early figures published in the *Board of Trade Journal* for February 17, 1920, gave each group a relative importance corresponding to the number of quotations, in place of the equality of importance indicated in the text.

forms an important material has reduced the weight (*i.e.*, the number of separate price series) assigned to it in the raw state or as coke. The quotation of furnace coke may appear to be in conflict with the principle here enunciated, but it was thought desirable to utilize the indications of the market for coke to the extent of one quotation out of the ten assigned to coal.

The weight assigned to petroleum is greater than its relative importance in 1907 would justify, but the greatly increased use of petrol and of oil fuel appears to justify this departure from the 1907 standard.

The list of articles to be quoted is not confined to raw materials. The number of manufactured commodities used is, however, limited. Goods of a representative character and standard description are necessary and the range of choice is not very extensive.

It is not proposed at present to compute index-numbers of the new series for any sequence of past years. We are less concerned with new views of what has happened in the past, yielding, perhaps, results which will differ but little from the indications of existing index-numbers, than with measuring the changes of the future as they occur. It is not to be expected that the new mode of calculation would yield fundamentally different indications from those which have already been recorded.

A link with the past is, however, desirable, and it is proposed to show, not only how prices in 1921 and subsequent years compare with those of 1920, but also how they compare with the prices of 1913 according to the new mode of measurement. For the intermediate years, it is not proposed to make calculations. They are unnecessary as links in the chain, since if the geometric mean is used, the result of direct comparison with any earlier period is identical, within the limits of precision of the arithmetic, with the compounded results of year by year steps, provided that the list of items has not been modified in the interval. The disturbances of markets owing to the general upset of the war, and to the establishment of control over many important articles, were such as to qualify the serviceability of calculations for this period. What has already been done in the way of measuring price fluctuations during the war may probably suffice for present needs, and the difficulties of piecing together broken series need not be solved.

So far as possible, it is proposed to obtain weekly quotations of prices, and to make the monthly index an average for the month, as in the case of the old Board of Trade index-number, not a measure of the position on a definite day, such as the first or last day of the month. Each month the average price-change compared with the

corresponding month of the preceding year is to be computed. The combination of the monthly variations into a mean annual figure is a matter the precise detail of which remains open to further consideration, after careful examination of the data yielded by the monthly calculations. If the figures of progress month by month are furnished, this is hardly a matter of great importance. Though the general outline of the new procedure has been the subject of discussions extending over a fairly long period, the actual decision to adopt this procedure is sufficiently recent to have left insufficient time for an exhaustive study of some of the details, mainly those not related to the action to be taken immediately. Before the first year is completed the necessary examination of the possibilities of using the monthly figures, or the necessity of an independent calculation for the whole year, will be carried out. To the extent to which different series of prices are used for the same (nominal) article at different seasons, the latter course presents certain difficulties of its own.

It may be proper to remark here that, in strictness, the use of identical weights, or the equivalent procedure of multiplying quotations of the same class of commodity, for each season of the year is a procedure not free from criticism. The determination of the proper seasonal variations of weights, especially in view of the liability of seasons to vary from year to year, is a task from which, I imagine, most of us would be tempted to recoil. At any rate no proposal for such seasonal variation of weights is included in the plan of action approved for immediate adoption.

The comparisons given in the table on page 186 of the relative importance assigned to different groups of commodities in the new index-number and in other index-numbers to which reference has been made in this Paper may be of interest.

In the case of the Bureau of Labor Statistics index-numbers the assignment of articles to the groups here used is subject to a little doubt, but an incorrect grouping of one or two articles will not affect the broad contrast between these numbers and the English numbers. It may be noted that in the *Bradstreet* number for November 1, 1920, foodstuffs account for roughly one-third of the total and in that for February 1, 1920, for a quarter only of the total.

A remarkable feature of the table is the contrast between the relative weight assigned to food in the old Board of Trade number (and in the revised index-number of the Bureau of Labor Statistics) and in the other numbers, and it may be noted that, as between food and other things, the relative weights assigned in the *Economist* and *Statist* numbers differ little from those of the new Board of

Trade number. The relatively small importance assigned to industrial materials in the old Board of Trade index-number appears to be due, in the main, to the absence of information regarding the value of the finished products of the various industries at the time when it was designed, and the use of a weighting in proportion to expenditure on raw materials where it is now proposed to use expenditure on finished goods. Miscellaneous industrial commodities receive greater relative consideration in the *Economist* and *Statist* calculations, and the place assigned in these to metals and minerals appears to be inferior to that to which their real importance entitles them. If we were able to deal with the products of the miscellaneous industries instead of with their principal raw materials, the independent importance of iron and steel might properly be diminished in view of its reflection in such finished goods.

Relative weights.

Group of articles.	Board of Trade.		<i>Economist.</i>	<i>Statist.</i>	<i>Times.</i>	U.S.A. Bureau of Labor Statistics.	
	Old.	New.*				Pre-war.	Revised.†
Cereals	194	113	137	156	200	76	146
Meat and fish	229	113	68	133	100	87	210
Other food	229	127	159	133	200	111	152
Total food	652	353	364	422	500	274	508
Minerals and metals	118	293	182	156	200	194	151
Textiles	144	207	227	178	150	238	129
Other materials	86	147	227	244	150	294	212
Total not food	348	647	636	578	500	726	492
All articles	1,000	1,000	1,000	1,000	1,000	1,000	1,000

* Based on the number of price-series in each group. In comparing with other index-numbers, the fact, noted above (p. 183), that the importance assigned to maize is exclusive of its importance as a feeding stuff should be remembered.

† The relative expenditure weights vary from year to year. The numbers in the table show the estimated relative expenditures for 1909.

In another feature the distribution of emphasis is different in the new Board of Trade number and the unofficial numbers. Iron and steel account for only a quarter of the minerals and metals group of the *Economist* and two-sevenths in the case of Sauerbeck's index. *The Times* index-number assigns two quotations to iron and

steel out of eight to metals and minerals. The old Board of Trade weighting gave a position intermediate between that of the *Economist* and *The Times* on the one hand and the Sauerbeck arrangement on the other. As has been pointed out, the new Board of Trade scheme gives greater importance to iron and steel than to all other metals and minerals. Among textiles the old and new Board of Trade indices assign to cotton an importance as great as or greater than that of all other textiles. The *Economist* gives it a proportion of 4 to 6 and the Sauerbeck index assigns to cotton only a proportion to all other textiles of 2 to 6.

With these broad comparisons and contrasts I shall pass to other features, leaving Appendix II to tell its own story to the interested student, who may desire to ascertain the precise place assigned to any individual item among the 150 articles for which particulars are to be utilized. It may be found that, in some cases, the most appropriate selection of the quotation to be used has not been made, and assistance in effecting improvements in this respect will be welcomed. In addition, certain of the items selected, though quotable now, may not be able to be traced back through 1920 or to 1913. Should this be the case, the calculations for the earlier months of 1921 may not utilize the whole of the 150 price-series. A year hence, a broader selection may be found possible for use in tracing future movements.

The sources and nature of the price data.

In my efforts to trace the precise effect on different index-numbers of the use of particular sources for the price quotations, the difficulties encountered have been referred to earlier. The quotations used in compiling *The Times* index are set out in detail each month, though the precise grade of commodity and the locality of the market whose price is utilized are not shown in all cases. The tables of prices given weekly by the *Economist* and the *Statist* do not appear to furnish the actual data used for the index-numbers of these journals, and the Washington Bureau has not furnished, so far as I can ascertain, the full detail of its price quotations since those for 1916 were published.

In the appendix will be found a statement of the sources of the prices to be used for the new Board of Trade index and a sufficient description to enable a student to secure the data for himself during any interval between the publication of detailed tables of the particulars, except in the case of a few quotations where reliance is to be placed on prices furnished by trade experts in the absence of satisfactory public quotations. Just as the details of the old Board

of Trade index were accessible with similar exceptions, so will the basis of the new compilation be accessible. If anyone desires to test some different procedure for combining them, no serious obstacle will stand in his way. If it were possible in all cases to use open market quotations, that course would be followed, but the available material did not in every instance meet the needs of the case.

As a point of importance in the scheme for the new index-number has been the extent to which the dealings in any commodity were influenced by, and exerted influence upon, the currency and credit resources of the country, it has been deemed proper to depart in one respect from the ordinary practice of makers of index-numbers in this country. Dutiable goods have usually been quoted *ex* duty for the purpose of such compilations. It is proposed to take these prices *plus* the duties in the new calculations.

Some materials of such importance that they cannot be omitted from our survey are dealt in otherwise than in open market for the most part. The principal transactions being carried out in accordance with contracts extending over a period of some duration, the dealings which do take place in the way of public sales are apt to represent either an urgent need for supplies on the one hand or a pressing necessity to realize holdings on the other. The actual prices made may or may not reflect the general terms on which manufacturers are acquiring their supplies. A particular case is that of *heavy chemicals*, and in this instance the best that could be done appeared to be to make a selection from articles quotable, even if they were not precisely those which would otherwise have been chosen. Soda crystals and sulphuric acid have been selected, these being generally in strong demand, and it is believed that the quoted prices represent fairly well the terms of the general business done. If a better course is discovered, it will be easy to substitute other quotations from the date when they become available

Tobacco and *sugar*, too, are imported direct by the great manufacturers, so that the market is not necessarily a mirror of price conditions in the trade. For sugar the quotations of an imported sugar not ordinarily further refined after importation (British West India crystals) and of a refined British sugar (Tate's cubes) are regularly available and it is proposed to use these, at any rate under present conditions. For tobacco, the reports contained in the circular of a leading mercantile firm in the trade are to be utilized.

Various difficulties have prevented the attainment of the desired solution of the problem of selection in the case of *leather*, regular and reliable quotations of tanned leather having ceased to be procurable in the stagnant condition of the leather market.

Sales are, for the time, confined to retail quantities or are the subject of special arrangements. No help could be found in the technical journals which give special attention to the trade, and the Association of Factors, Merchants and Importers of Leather, Hides and Tanning Materials, when applied to for assistance, answered that it was "impracticable" to furnish quotations of standard grades of leather. Initially, therefore, market quotations of hides will be used, since they are available, but at a later date they may be replaced or supplemented by quotations for leather. We are, however, informed that the absence of reliable quotations of representative classes of leather, whose quality can be assumed to be fixed, is not an accident of the present state of the leather market, but a consequence of permanent conditions.

Reference has previously been made to cases in which dealings in some commodities are only active at certain seasons. A useful illustration occurs in the case of *fish*, and the selection of kinds of fish for quotation has been made with a view to all the year round quotations. If it should not be found possible to get satisfactory Billingsgate quotations for bloaters, cod, haddock and plaice, the selected varieties, other varieties can be introduced at seasons when they are plentiful without seriously affecting the average price-index for fish, which is to be deduced by compounding the indications of the selected varieties.

A somewhat curious illustration of the difficulties connected with the securing of reliable data on which to base index-number calculations is afforded by the recent history of *sulphate of ammonia*, one of the chemicals whose price it is proposed to use. It was announced on December 18 last that the Ministry of Agriculture had induced manufacturers to reduce their prices from 26*l.* 13*s.* 6*d.* to 23*l.* 16*s.* per ton delivered to farmers, and to refund any sum in excess of the lower figure paid for deliveries during August to December, 1920. This refund throws into confusion, to the extent of its importance in the aggregate index, any calculation based on the "budget" method, so far as the months affected are concerned. As the current balance of commercial demand and supply had to take into account prices charged at the time, it would appear to be quite appropriate to leave any calculations based on the actual prices as originally charged unaltered from the standpoint frequently indicated in the course of this Paper. A spasmodic effect, somewhat similar to that of a temporary special price rebate, may have to be taken into account at the time of the refund, and the case illustrates the point that the results of the calculations must not be treated as if the measurements could be made very precise, though the

arithmetical work done on them must be done as carefully as if they were precise, so as not to introduce errors of an unintentional character.

Possible new results from the new data.

In carrying out the work of the new index-number there will be obtained each month 150 measures of the price variation in different markets from the level of a year previously. The variation from the preceding month could also be secured, if desired, of course. If the quotations are sufficiently independent, the distribution of the 150 variations should, when the general price-level is stable, accord with the well-known law of error. If prices are rising the curve showing the "scatter" of the different price-movements should take a skew form with its mode to the right of the mean, and if they are falling the mode should be to the left of the mean. It appears not beyond hope that a study of the changing shapes of the curves of distribution may enable us to learn something more than the mere average movement compared with past dates. It does not appear possible to forecast the nature of indications which may be found in the changing forms of distribution. It may take a long time before any interpretation can be confidently made of the significance of various types of curve or of change. But it appears at any rate worth while to examine the material, when it becomes available, with a view to the recognition of types of disturbance, and possibly scenting the approach of commercial cyclones or anti-cyclones. I am bound to admit that some efforts in this direction have not met with any reward, but this may be due to the absence of material of the appropriate character, or it may be due to the futility of the search for a system of commercial meteorology. But I do not think we are ready to abandon that search without some additional effort. So long, however, as the markets in a number of important commodities are officially controlled, it is improbable that useful results of the kind suggested will be derivable from the proposed analysis.

APPENDIX I.

Wholesale prices, 1919-20.

Month.	Board of Trade, 1900 = 100.	<i>Econo- mist</i> , 1901-5 = 100.	<i>Statist.</i> 1867-77 = 100.	<i>Times</i> , Decem- ber 31, 1913 = 100.	Bureau of Labor, 1913 = 100.	Brad- street.	Federal Reserve Board, 1913 = 100.
1913. Monthly average	Average. 116·5	End of month. 122·4	End of month. 85·0	End of month. —	Average. 100	End of month. 9·19	Average. 100
1919.							
January	286·7	265·7	192·1	232·2	203	17·63	195
February	287·9	263·8	187·5	231·1	197	17·22	189
March	295·3	259·4	184·7	224·3	201	17·28	191
April	292·3	262·4	184·6	227·6	203	17·24	196
May	274·6	272·2	194·6	240·7	207	18·09	202
June	277·9	281·3	199·4	244·7	207	18·90	203
July	281·8	293·2	206·4	252·0	219	20·00	211
August	299·9	295·9	212·7	256·5	226	19·47	218
September	308·3	299·4	214·8	256·9	221	19·52	211
October	323·9	308·9	224·3	277·4	223	19·90	212
November	336·7	317·5	231·0	282·0	230	20·18	219
December	345·9	334·7	235·2	296·9	238	20·36	226
1920.							
January	356·6	353·1	245·3	313·4	248	20·87	242
February	368·7	370·9	260·4	325·1	249	20·79	242
March	375·2	379·6	261·8	329·0	253	20·71	248
April	374·4	374·2	266·1	329·2	265	20·73	263
May	371·9	372·7	260·0	323·4	272	19·88	264
June	393·5	356·7	255·7	307·4	269	19·35	258
July	404·3	358·0	254·6	305·8	262	18·83	250
August	379·4	352·0	253·5	298·9	250	17·97	234
September	385·5	347·5	248·7	295·1	242	16·91	226
October	377·5	326·1	239·9	290·1	225	15·67	208
November	364·4	299·7	223·8	257·7	207	13·63	190
December	352·2	269·3	207·2	240·3	189	12·66	171

APPENDIX II.

The following table shows the relative importance in 1907 of the various classes of goods produced in the United Kingdom for consumption or export or imported into the United Kingdom for direct consumption. So far as the results of the Census of Production for 1912 have been examined they do not appear to be discrepant from those obtained in 1907, and consequently, the table can be taken as indicative of the normal pre-war agricultural, industrial and commercial activity of the United Kingdom. In the case of

petroleum, however, some allowance for its increased importance since 1907 has been made.

I. Grain :—				VI. Cotton	....	16
Wheat	....	7	17	VII. Other textiles :—		
Barley	....	5		Wool	....	9
Oats	....	2		Linen	....	2
Maize	....	1		Silk	....	2
Rice, &c.	....	2		Jute	....	1
II. Meat, poultry, fish :—				Hemp	....	1
Beef	....	6	17	VIII. Miscellaneous :—		
Mutton	....	3		Chemicals	....	5
Pork	....	5		Tallow	....	1
Poultry	....	2		Oil	....	1
Fish	....	1		Paper	....	2
III. Other food :—				Leather	....	4
Milk, butter, cheese	....	7	19	Rubber	....	1
Fruit and vegetables	....	5		Timber	....	4
Sugar	....	2		China, glass	....	1
Tea and coffee	....	2		Bricks	....	1
Cocoa	....	1		Stone	....	2
Tobacco	....	2				
Total food, drink and tobacco	53			Total : Commodities other than food, &c.	97
IV. Iron and steel	....	24				
V. Other metals and minerals :—				Total : All commodities	....	150
Coal	....	10	20			
Petroleum	2			The total number of quotations used is	179
Copper	4					
Lead	1					
Nickel	1					
Tin	1					
Zinc	1					

QUOTATIONS

I. GRAIN.

Wheat—

3. Grain—

1. English wheat : Gazette average.

Imported wheat : c.i.f. prices per 480 lbs. fixed by Wheat Commission ; afterwards spot prices Liverpool per 100 lbs.—*Corn Trade News*.

1. North American No. 2 Northern Manitoba or No. 3 Red Winter, or No. 1 Northern Spring according to season.

1. Australian, Argentine or Indian according to season.

3. Flour—

1. London, G.R. ; afterwards average of Whites and Town Households.

1. Birmingham, G.R. ; afterwards local quotation.

1. Glasgow, imported flour (Canadian).—All from *Miller* per 280 lbs.

1. Bread—

1. Ministry of Labour monthly United Kingdom average.

*Barley—*2. *British—*

1. Malting : average prices of British malting for Bristol, Liverpool and London.

1. Gazette average from Ministry of Agriculture's *Return of Market Prices*.

3. *Imported—*

1. Californian malting per 448 lbs.	$\left\{ \begin{array}{l} \text{Return of Market Prices, average} \\ \text{Bristol, Liverpool and London,} \\ \text{or ex ship price from London} \\ \text{Corn Circular.} \end{array} \right.$
1. American feeding per 400 lbs.	
1. Canadian feeding per 400 lbs.	

Oats—1 grain ; 1 meal.

Grain—

1. No. 2 White Canadian spot, or American clipped white, Liverpool, per 320 lbs.—*Corn Trade News*.

Meal—

1. Midlothian oatmeal, Edinburgh, per bag, or London, per ton.—*Miller*.

Maize—1 grain (the full value of maize is included in meat).

Yellow La Plata per 100 lbs. spot Liverpool.—*Corn Trade News*

Rice, &c.—

1. Rice No. 2. Rangoon per cwt.—*London Corn Circular*.

1. Tapioca fine medium or finest flake per cwt. Liverpool price list.—*Produce Markets Review*.

II. MEAT, POULTRY, FISH.

(Weekly quotations from the *Return of Market Prices* except for fish and Danish eggs.)

5. *Beef—*

Scotch short sides, 1st London.

English, 1st Leeds.

Cow and Bull, 1st Birmingham.

Irish port killed, London.

Argentine chilled : average fores and hinds, London.

3. *Mutton—*

Scotch mutton, 1st London.

English mutton, 1st London.

New Zealand lamb, 1st London.

5. *Pork—*

British port, 1st, average Birmingham, Leeds, London and Manchester.

Wiltshire smoked bacon, 1st Bristol.

Irish smoked bacon, 1st Liverpool.

American sides, green, 1st Liverpool.

Danish sides, green, 1st London.

All above are per cwt.

2. *Poultry—*

Irish eggs (top quality) per 120, Liverpool.

Danish eggs (first) per 120, London.—*Grocer*.

1. *Fish—*

The lower prices of bloaters, cod, haddock and plaice from the Billingsgate Report in *The Times* (Saturday) are used to calculate one index-number for fish.

III. OTHER FOOD.

1. *Milk*—

Average of contracts for two London institutions.

4. *Butter and margarine*—

Irish creamery, 1st Liverpool.

Danish, 1st London.

New Zealand, 1st London.

Coconut oil, top price.—*Grocer.*

2. *Cheese*—

Cheddar, 1st Bristol.

Canadian (Liverpool) or New Zealand (London) 1st, according to season.

2. *Potatoes*—

1st, average British earlys, and 2nds, Jersey for summer. Average British Queen, Edward VII and Up-to-date for rest of year. Average of Birmingham and London prices in each case.

1. *Onions*—

British, 1st, London.

1. *Apples*—

Nova Scotian or Australian 1st, according to season.

1. *Oranges*—

Spanish, Jamaican or South African according to season.—*Grocer*, lower price.

All above except milk, coconut-oil and oranges from Ministry of Agriculture's *Return of Market Prices.*

2. *Sugar*—

British West India crystals, lower price.—*Grocer.*

Tate's cubes.—*Grocer.*

1. *Tea*—

Indian average of market prices.—*Tea Brokers' Association Circular.*

1. *Coffee*—

Costa Rica, good to finest.—*Grocer*, lower price.

1. *Cocoa*—

Guayaquil, raw.—*Grocer*, lower price of range.

2. *Tobacco*—

Circulars of Messrs. Frank Watson and Co., Ltd., mean of highest and lowest monthly quotations.

Virginia leaf.

Kentucky leaf.

In the case of sugar, tea, coffee, cocoa and tobacco where prices are quoted in bond the duty is to be added.

IV. IRON AND STEEL.

The quotations are the "home" prices in the weekly prices current of the *Iron and Steel Trades Journal* or from the *Foundry Trade Journal*, with which the former is incorporated from the beginning of 1921 (supplemented by the *Iron and Coal Trades Review* and the *Metal Bulletin*).

5. *Pig iron*—

Hematite: West Coast, mixed numbers.

Cleveland: No. 3 Foundry, G.M.B.

Derby, Leicester and Nottingham: No. 4 Forge.

Northamptonshire: Basic.

Scottish: Foundry No. 1.

3. *Wrought iron*—

Cleveland : Crown bars, standard quality, ordinary sizes and merchants' lengths.

Hoops.

Marked bars (Staffs.).

4. *Steel*—

Billets, soft steel d/d.

Tinplate and sheet bars d/d.

High-speed tool steel : finished bars, 14 per cent. tungsten.

Heavy steel melting scrap (without analysis).

12. *Steel finished*—

England and Wales : Rounds and squares, 3 ins. to $5\frac{1}{2}$ ins.

Angles, 4 ton lots (min.).

Rails, heavy (60 lbs. and up).

Boiler plates.

Hoops (Staffordshire).

Galvanized corrugated sheets, 24g.

Galvanized fencing wire, 8g., plain.

Rivets, $\frac{3}{4}$ in. diameter.

Tinplates, coke, I.C. 20 by 14 ins., 112 sheets, 108 lbs.

Scotland : (Angles and bulb angles, tees and zeds, flat bars, rounds and squares, channels.)

Ship plates, $\frac{3}{8}$ in. and up.

Joists.

V. OTHER METALS AND MINERALS.

The coal quotations are from the market reports in the *Iron and Coal Trades Review*, supplemented by the *Colliery Guardian* ; lower price of a range is taken. Quotations for copper, brass, lead, tin and spelter are from the *Iron and Steel Trades Journal* or *Foundry Trade Journal*, and of nickel from the *Metal Bulletin* ; lower price if a range is given.

10. *Coal*—

South Wales : Large steam for export ; best bunker smalls or smokeless seconds.

Durham : Gas coal ; average furnace coke.

Lancashire : best house coal.

Yorkshire : Barnsley best silkstone ; Yorkshire hards.

Midlands : Derby best brights ; Derby best small nuts.

Fifeshire : Screened navigation.

2. *Petroleum*—

American standard white in barrels at London.

Motor spirit No. 1 per gall. ; lubricating oil—American pale per ton lower quotation. Combined index-number for these two.—*Petroleum Times*.

4. *Copper*—

Electrolytic.

Solid drawn tubes.

Wire.

Brass sheet to 10 W.G.

1. *Lead*—

English.

1. *Tin*—

Straits.

1. Zinc—
Ordinary spelter.
1. Nickel—
Refined, home trade.

VI. COTTON.

2. *Raw cotton*—
Middling American
Fully good fair Egyptian, } Official value; spot Liverpool.
Sakellarides
7. *Yarns*—
American: 32's twist; 40's weft; 50's weft; 2/60's.
Egyptian: 60's twist; 80's weft; 100's weft.—*Cotton*, lower price.
7. *Cloths*—
32 ins. Printers, 116 yds., 16 by 16, 32's and 50's.
36 ins. Shirtings, 76 yds., 19 by 19, 32's and 40's.
38 ins. Shirtings, 38 yds., 18 by 16, 10 lbs.
39 ins. Shirtings, 37½ yds., 16 by 15, 8½ lbs.
42 ins. Jaconets, 20 yds., 20 by 18
30 ins. Drills, 40 yds., 14 lbs. } *Manchester Guardian*, lower
36 ins. Sheetings, 40 yds., 12 lbs. } prices.

All quotations, except those from *Manchester Guardian*, are from Tattersall's *Cotton Trade Circular* or *Cotton* (which are identical).

VII. OTHER TEXTILES.

Wool—Quotations from *Wool Record*: lower price where a range is given.

1. *Rags*—
Average price of stockings at Dewsbury.
1. *Wool*—
Southdown tegs or ewes 56's-58's, washed, Bradford.
2. *Tops in Oil*—
Merino, 64's average.
Crossbred Colonial carded, 48's.
5. *Yarns*—
Worsted, weaving: 2-15's carpet, 28's to 32's; 2-48's, 64's.
Hosiery, 2-20's, 48's Colonial.
Alpaca, 1-28's medium.
Woollen, 8 skeins, solid shades, 48's-50's.

Linen—Prices current in *Linen Trade Circular*.

2. *Yarns*—
Line wefts, 80's.
Cambric warps, 45's.

Silk—

2. *Raw silk*—
China, Blue Elephant
Milanese } *Times Trade Supplement*.

Jute—

1. *Raw jute*—
First marks.—*Times Trade Supplement*.

*Hemp—*1. *Raw hemp—*Manila J. Grade.—*Times Trade Supplement.*New Zealand High point fair, spot.—*Times* (Saturday).

Calculate variation on each to produce one index-number for hemp.

VIII. MISCELLANEOUS.

5. *Chemicals—*First four are Manchester prices from the *Chemical Trades Journal.*

Sulphuric acid (pyrites), 168.°

Ammonium sulphate, London, net.

Sodium carbonate (soda crystals), bags, carriage paid.

Aniline oil (pure).

Quinine sulphate.—*Economist.*1. *Tallow—*Australian mutton tallow, good, London.—*Times* (Thursday).1. *Oil—*Linseed, raw, Manchester.—*Chemical Trades Journal.*2. *Paper—*Sulphite bleached, good quality } *World's Paper Trade*
Mechanical wood pulp, pine, 50 per cent. moist } *Review.*4. *Leather—*Ox and heifer hides, 1st.

70/79 lbs. }

60/69 lbs. }

50/59 lbs. }

49 lbs. and under }

Combine into one index-number.

Combine into one index-number.

Cow Hides —

Heavy—1st }

Light—1st }

Combine into one index-number.

Calf-skins—

17/25 lbs.

Manchester prices weekly from *Leather Trades Review.*1. *Rubber—*Ribbed smoked sheets 1st, spot, lower price.—*Times* (Saturday).4. *Timber—*From *The Builder.*

Good building deal, 4 by 11 ins. per standard.

Tongued and grooved flooring, 1 in. per square.

Dry wainscot oak, per foot super., as inch lower price.

Dry mahogany, per foot super., as inch, lower price.

1. *China, glass—Builder.*

English sheet glass in crates of stock sizes and in squares in ordinary sizes 21 oz. 3rd, per foot.

1. *Bricks—*

3 inch clay bricks, prices furnished by the Scottish Employers' Council of Clay Industries.

2. *Stone—Builder.*

Bath stone, delivered Paddington, per foot cube.

Slates, 1st quality Portmadoc, 18 by 9, delivered London area per 1,000 of 1,200.

APPENDIX III.

Data of U.S. Bureau of Labor Statistics.

The unweighted index-numbers are as given in Bulletin 149. The weighted index-numbers are as stated in Bulletin 181, which also furnishes a revised series of unweighted index-numbers. The geometric averages are calculated from the data given in Bulletin 149 and earlier Bulletins.

Year.	Bureau index.		Geometric average.	Year.	Bureau index.		Geometric average.
	Un-weighted.	Weighted.			Un-weighted.	Weighted.	
1890	112.9	112	113.2	1902	112.9	117	111.0
1891	111.7	111	112.2	1903	113.6	115	112.2
1892	106.1	103	106.5	1904	113.0	118	111.3
1893	105.6	105	105.8	1905	115.9	118	114.2
1894	96.1	92	96.1	1906	122.5	120	120.8
1895	93.6	95	93.6	1907	129.5	129	126.6
1896	90.4	90	89.9	1908	122.8	126	118.5
1897	89.7	92	89.3	1909	126.5	136	121.4
1898	93.4	96	93.0	1910	131.6	141	125.7
1899	101.7	104	100.9	1911	129.2	130	121.8
1900	110.5	111	109.5	1912	133.6	141	125.7
1901	108.5	110	107.2	1913	135.2	142	127.4

APPENDIX IV.

The following table gives the new Board of Trade index-number for the period January, 1920–February, 1921, as stated in the *Board of Trade Journal* for March 17, 1921.

Percentage of prices to the average prices of 1920.

Groups.	1920.						
	Jan.	Feb.	March.	April.	May.	June.	July.
Cereals	89.3	88.8	97.7	101.6	102.5	104.3	103.0
Meat and fish	98.5	91.9	88.6	93.6	91.8	92.9	102.4
Other food	94.9	101.4	106.5	108.2	106.7	108.5	101.4
Total food	94.2	94.2	97.7	101.3	100.4	102.0	102.2
Iron and steel	82.7	90.2	96.4	100.4	105.4	109.1	108.2
Other metals and minerals	96.7	101.8	100.3	97.0	101.0	101.0	101.6
Cotton	112.4	127.0	127.4	127.9	123.9	115.7	108.0
Other textiles	113.6	120.6	121.7	123.4	117.7	108.7	99.2
Other articles	99.0	104.0	107.1	108.0	104.9	100.2	99.9
Total not food	98.3	105.7	108.0	108.9	109.0	106.4	103.5
All articles	96.8	101.5	104.2	106.1	105.9	104.8	103.0

NOTE.—In this table the aggregate index-number is the geometric average of the 150 separate index-numbers for individual commodities.

Percentage of prices to the average prices of 1920—Contd.

Groups.	1920.					1921.	
	August.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Cereals	102·2	103·3	106·7	106·3	96·2	90·5	78·4
Meat and fish	106·0	106·9	109·1	111·4	110·6	108·0	100·8
Other food	96·1	94·2	97·2	94·5	92·3	88·0	81·6
Total food	101·2	101·0	104·0	103·4	99·1	94·8	86·2
Iron and steel	107·0	107·0	104·2	99·2	93·8	88·6	79·0
Other metals and minerals	102·8	103·6	102·3	100·1	92·3	85·5	80·7
Cotton	105·3	96·1	78·9	65·8	52·9	46·7	40·6
Other textiles	94·6	93·9	84·2	76·3	67·0	61·1	55·6
Other articles	98·2	100·8	99·5	94·3	85·9	80·4	78·6
Total not food	101·9	100·9	94·9	88·2	79·2	73·1	67·3
All articles	101·6	101·0	98·0	93·3	85·7	80·1	73·4

DISCUSSION ON MR. FLUX'S PAPER.

MR. G. UDNY YULE : Mr. Chairman, I am very pleased to propose a vote of thanks to Mr. Flux for his Paper, and particularly pleased since on first reading this Paper I found myself in almost complete agreement with him on every point of importance. The criticisms which Mr. Flux made on the old index-number of the Board of Trade are criticisms which I have made again and again to students. I think we are agreed that that number was an unsatisfactory number. It professed to be based on the consumption standard ; but owing to the confusion of base periods and reference years (1881-90 for the values consumed, first 1871 and then 1900 for the reference year), the schedule of quantities virtually assumed as the consumption schedule bore no relation at all to the facts, and the virtual change of weighting brought about by the change of reference year led to one of the largest changes which he had ever noted as due to an alteration of weighting. Where the "consumption standard" is the basic idea in forming an index-number, it should be recognised that the values taken as weights must be those of the year of reference, *i.e.*, the year in which numbers are made equal to 100. Even before the war it had become urgently necessary that some entire reconstruction of the number should be effected. The main proposals are now : first, the use of market prices, to the exclusion of import

and export values ; second, the use of the geometric mean ; third, the use, not of direct weights, but of weighting by number of quotations. On each of these points I agree, but I would like to traverse them. So far as my own very limited experience goes, export and import values are not satisfactory. They are very sluggish in movement, lagging behind markets, as Mr. Flux has stated, and I doubt if all the values are very trustworthy, especially where goods are sent on consignment. And finally, the classification of commodities is not always sufficiently detailed to give an approximately homogeneous group. Referring to a remark on page 169, surely if the composition of the group varies, the resulting index-number is an index-number rather of expenditure than of price ? During the war some of these changes in the composition of groups of commodities were very large, and the resulting changes in value quite misleading. Thus for "Timber: Hewn or Split," one of the two groups for timber used in the *Statist* number, we find an average value per load in 1914 of 2.089*l.* and in 1918 6.368*l.*, an increase in the ratio of 100 : 257. But if we reckon the quantities of 1914, for each of the five sub-classes given, first at the prices of 1914 and then at the prices of 1918, we get an increase in the ratio of 100 : 347. We ceased importing some of the more valuable timbers during the war, and the average value of all sorts together was no proper index to the change in prices. Next as regards choice of mean. The choice of the method of averaging depends primarily on the aim with which the index-number is computed. Mr. Flux (page 175) has distinguished two aims, and I also have been accustomed to distinguish two. But, in view of a later remark of Mr. Flux (page 188), it seems to me that the two must be increased to three :—(1) To find the change in money-cost of the things we buy—the retail-prices problem, in the solution of which the dominant method is still the method used by Joseph Lowe in 1822 and in the *Labour Gazette* now. (2) To find the effect on prices of changes in currency—the problem that started the classical researches of Newmarch and of Jevons after the gold discoveries, not to mention the work of Shuckburgh Evelyn in 1798, of Arthur Young and of other writers in the early years of the last century. (3) To find the effect of price-changes on currency and credit. This seems to me to be the inverse of problem No. 2 and I feel bound to distinguish it ; for surely if No. 2 is the object—to find the effect of currency-changes on price—it is not legitimate to include duties with the prices ? The inclusion of duties is one of the objections, amongst many, raised to the work of Shuckburgh Evelyn, and it seems to me a legitimate objection. Whether they are included or no—and the proposal to include them has startled me a little—seems to me to be a matter for decision as between aim No. 3 and aim No. 2. But granted that aim No. 1 is barred—that *that* is the province of retail prices index-numbers—I concur with Mr. Flux that the consumption standard has no clear justification, and the geometric mean is the best mean to use. As regards this mean, I have always felt that Jevons was quite right in his conclusion and

wrong in his reasons. The geometric mean is the form of average appropriate to the handling of ratios or products, just as the arithmetic mean is appropriate to the handling of sums, differences, or other linear functions. It gives complete consistence of results. For the geometric mean alone is it true that the mean of a series of ratios is the same as the ratio of the means, so that for a given weighting the ratio of the means for two years is independent of the year chosen as reference year. Finally, on the question of weighting, I also agree with Mr. Flux that, having regard to the aim in view, a weighting by number of quotations is adequate, and preferable in that it does not attach too great a weight to the idiosyncrasies of one quality of a commodity or of one market. The only point on which I am not clear is, why it was proposed after weighting within the groups, to combine them as of equal weight. But beyond and above all questions of averaging, I am glad to note that Mr. Flux proposed to give the fullest possible detail; all prices and all index-numbers for individual commodities, I hope, as well. This will enable any worker directly and without difficulty to apply any process that he wishes to test—fancy weighting according to the stability of the prices of different commodities or anything else. And further, it will enable a reader to compile, if he does not find it given, the frequency distribution of the index-numbers and see how they range round the given average. I am glad to see that Mr. Flux has been doing some work on the frequency distributions of index-numbers. I myself have done a certain amount on the subject and have compiled the distributions of Sauerbeck's (the *Statist*) numbers for every year from the commencement to date. The numbers (45) in any one year are too few to give any clear picture of the form of the distribution but, combining several years, my general impression is that the distributions do not differ much from symmetry except in a time of rising prices, when a few commodities soar out of all proportion to the rest. The dispersion is high when prices are rising, low when they are falling, or steady for a time after the fall. I have constructed a diagram of Sauerbeck's numbers, which shows not only the means, but every individual number by a small dot, so that the student can see the means meandering through the wide haze of dots representing individual numbers, and so have the importance of the dispersion thoroughly enforced on his mind. It is interesting to see, on such a chart, how the dots contract, concentrating round the means, during the period of the great fall in prices; how they start scattering again in the rise after 1896, and spread widely all up and down the sheet in the later years of the war. Before the war the interquartile-range, the central range within which half of the index-numbers lay, was between ± 9 and ± 12 points, on an average just about ± 10 points. In the last years available it was as great as 45 to 50 points. I have already occupied so much time that I can only touch on the problems of detail in construction that Mr. Flux has mentioned. My own inclination would be to form the index-number for any month by taking ratios to the corresponding month of the year being used for

reference, the year before presumably, as this would avoid any difficulties with seasonal commodities. I should then form the annual average by the geometric mean of the monthly figures. Others will, I hope, discuss this point. I think the Society is greatly indebted to Mr. Flux for a most interesting and valuable paper, and for thus bringing his proposed methods before them for discussion. Perhaps I should add, having expressed such cordial agreement with Mr. Flux, that our conclusions were entirely independent, except in so far as my own had been formed by the study of previous papers by the same author.

Sir GEORGE PAISH: It is a very great pleasure to second this vote of thanks. I am sure we are all very much indebted to the reader for his most admirable Paper. Clearly, index-numbers in the past have not been altogether satisfactory for some of the purposes for which they have been used in recent years. There is another object than that referred to in the paper for which index-numbers are being used, and that is the fixing of wages. They have been considered as analogous to the rise in the cost of living, and all kinds of arguments have been based upon them for the purpose of bringing about an increase on corresponding lines in wages. Now, in my judgment, index-numbers of wholesale prices were never intended for such a purpose. They are much too crude for that purpose. Wholesale prices at certain times and under certain conditions have relatively little to do with retail prices. Retail prices are the only true basis for indicating the rise in the cost of living, as they include not only the wholesale price of food and raw material but wages and taxation. I hope when the Board of Trade comes to consider this question of relating index-numbers to the cost of living it will compile a second index-number, an index-number based purely upon retail prices, and, as far as possible, weighted, in order to spread the effect of price over current family budgets. Undoubtedly the proposal Mr. Flux has made with regard to including 150 commodities is most admirable, because the price of 150 commodities will undoubtedly give a very much better indication of the true course of wholesale prices than only 46. Of course it is clear that the movement of price of the larger number of commodities will be much the same as the smaller number, but it will be nearer to the actual, or should be nearer to the actual. I would perhaps say one other word about the matter, and that is on the question of the base line. Clearly the prices current during the war are not a suitable base line. It may be that the nation is expecting wages to fall correspondingly to the fall in the cost of living. In that event we must find out what was the real rise in the cost of living during the war. As yet we have not discovered it. No compilation which has yet been made has given us the real rise in the cost of living. The question of weighting is one of very great importance. During the war obviously the weights changed. There has not been so much money available for luxuries. But hitherto luxuries have not

figured in the way they ought to have done. The index-number has been based upon the idea that no one should have anything but pure necessities. Clearly that is not a sound view, at any rate not in arriving at the cost of living as a basis for wages. Everybody needs a certain amount of luxury. I see even Mr. Flux, in his most admirable Paper, has not allowed for one very important matter. As we all know, the country has refused, or does refuse, to give up its beer. Well, beer is a very big item in the family budget of the working man; and if we exclude that we are certainly not arriving at the cost of living, as the working man refuses to give it up. I do suggest that if the Board of Trade is going to use an index-number for the purpose of arriving at the cost of living from year to year it should include a certain number of luxuries, at any rate it should have a real family budget of different classes of the community, and by combining those budgets arrive at what the people really do consume and what they spend their money on. I have very much pleasure in seconding the vote of thanks.

Mr. H. W. MACROSTY thought that Sir George Paish was under some misapprehension as to the purposes for which the Board of Trade index-number had been and could be used. The Board of Trade index-number of wholesale prices had never been used for any purpose whatsoever in connection with wages. The index-number of retail prices which was used to-day in connection with wages was the one compiled by what had been the Labour Department of the Board of Trade and was now the Ministry of Labour. That retail price index-number had its deficiencies, but it was sound for the purpose of measuring the variations in the cost of living between different periods. Having had to examine it in a good deal of detail within quite a recent period, he was fairly well assured that it was about as satisfactory a number as could be got. He agreed with what Mr. Flux had said with regard to the defects of the old Board of Trade index-number, but even a defective instrument might have its uses. He had found that when the Board of Trade index-number of wholesale prices was combined with the United States Bureau of Labour index-number of wholesale prices, and the respective indices were used as indications of the relative level of purchasing power in the two communities, the relation of sterling and dollar exchange worked out from these data for periods of three or six months at a time, had never varied more than about 1 per cent. from the average of actual market quotations from day to day. Of course that might mean nothing more than that the errors of the one index-number compensated for those of the other index-number; but at all events for the period since the exchange was "unpegged," those two index-numbers, imperfect as they might be, had acted as a true index of what the actual relation of sterling and dollars had been, so that the old Board of Trade index-number should not be condemned too severely. He agreed thoroughly with everything that Mr. Flux and Mr. Yule had said with regard to the

methods of calculating the index-number. The particular points which Mr. Yule raised would have to be thrashed out in the course of the next few months when the results began to come in. Personally he laid more stress on getting precision and accuracy of quotation than on anything else. It was quite evident that there might have to be a number of alterations from the list of quotations first compiled, but that could only be ascertained and dealt with as the results began to come in. He was sure that both Mr. Flux and the Department as a whole would thoroughly welcome any help in making the list representative and satisfactory.

MR. W. T. LAYTON : Mr. Chairman, I shall not detain you very long, since for reasons over which I have no control I have not had the advantage of reading this Paper before coming into this room. But I am very glad to have this opportunity of congratulating Mr. Flux on the new step the Board of Trade is going to take because I appreciate the need of it, not only as one of those who have had occasion to use index-numbers, but also, like Sir George Paish, as a former manufacturer of one of the index-numbers referred to here, viz., the *Economist* index-number—I am naturally not the original fabricator, but I was responsible for, shall I say, its re-birth, in 1911. I am a little surprised that Mr. Flux has not paid more attention to the point just mentioned by Mr. Macrosty, namely, the basis of his material. One of the most important advantages of this new plan is that Mr. Flux is going to calculate a market price index-number from a very large number of market quotations. I know from experience the difficulty of getting 40 good standard market quotations ; and it is really a matter for a Government Department and not for a private newspaper to undertake the very big task of collecting a really large number of quotations. At the same time it is essential that the number should be large, for anyone who has actually handled the figures knows how extremely difficult it is to get reliability in individual quotations. I think that although Mr. Flux points out in his Paper the variations between the different index-numbers, in his heart of hearts he probably feels as I feel, that it is extraordinary that during the war, when quotations were even more difficult to secure than usual, the wholesale price index-numbers, based on only between 40 and 50 quotations, have been so near together. A market quotation is a very difficult thing to obtain, and even when you have got it, its significance is by no means plain. The market quotations of iron and steel are, for example, an index not of what the industry is doing, but of what people expect the industry is going to do. If you average the market quotations of pig iron over a series of years, and then average the actually ascertained price as shown by the books of the firms manufacturing pig iron, it will be found that the latter figure is appreciably less than the average market quotation because the two curves do not follow one another at equal intervals. On the rise the average period for which a firm is booked ahead is longer than the average period for which it is

booked on the downward grade. Therefore the curves are close together on the downward and wide apart on the upward grade. Hence market prices do not even in anticipation exactly represent the receipts of the industry. That is just one illustration. There are many other difficulties in interpretation. It is only by increasing the number of quotations that the disturbing effect of defects in the data can be overcome. Turning to the question of method, I want to submit a point for Mr. Flux's consideration. He is now introducing in Great Britain a new index-number obviously to meet a demand for better information on the subject of prices. Mr. Flux is quite aware that precisely that same demand is being made in all the countries of the world; and speaking now from the standpoint of my colleagues on the economic section of the League of Nations, I am wondering what steps Mr. Flux has taken, if any, to consult with his colleagues in other countries who are equally at this moment engaged in producing index-numbers in order that these new indices may be compiled on a comparable basis. Norway, Sweden, Holland, and no doubt many other countries are starting index-numbers. As far as I remember, without having the data before me, the great majority of those countries are introducing their new index-numbers on the 40 or 50 commodity basis which has been current in this country so long. I would urge the desirability that, at a moment like the present when a new index-number is in fact being established in this country, an effort should be made to see whether some standard of comparability with other countries cannot be attained. In this connection I would like to say that, purely on practical grounds, and not in the least dealing with the theoretical aspect of the case, I, personally, am sorry for two reasons to see that Mr. Flux proposes to take the geometric mean. In the first place, so far as I know, practically no index-number in the world is based on the geometric mean. The second reason is that index-numbers such as Mr. Flux is going to produce will be used constantly in economic discussions between workpeople and employers. For example, yesterday a large employer in the Midlands told me that he constantly quoted wholesale price index-numbers at Works Committees and in other discussions with his workmen as an index of general economic conditions. The trouble is to explain the figures so that they command the confidence of workpeople. From this point of view, it is not enough that the retail price number should be simple. The workpeople in this country must also understand the wholesale price index; for though the wholesale price index-number does not affect their cost of living, it is, and must be, increasingly used in discussions on the wages situation and on the general economic situation. I venture, therefore, to suggest that for these two reasons it is unfortunate that the Board of Trade, however good the theoretical case may be, should adopt the geometric mean which is difficult to understand and which introduces, in international comparison, an entirely new element. I am very glad that Mr. Flux has emphasised the functions of his wholesale price index-

number. He desires to ascertain, in reference to wholesale prices, what is the extent of the influence of general economic conditions on all prices. He does not claim that he is producing a cost of living index-number; and he does not of course claim that he is producing an index-number of the general purchasing power of money, which would involve the introduction into the calculation of all sorts of other things, such as retail prices, rent, salaries, stocks and shares, and everything else that is bought and sold. The wholesale price index-number is not a measure of the general purchasing power of money, though all the wholesale price index-numbers are constantly quoted as such; and no doubt Mr. Flux will have his figure constantly quoted in the same sense. I think, perhaps, there is almost enough data in existence for calculating an index of the value of money, and perhaps Mr. Flux will next turn his attention to that further problem. But I would just say this word, firstly, that it is most important that when this index-number is published, its exact purpose, as defined in Mr. Flux's paper, should be constantly reiterated; and, secondly, that perhaps Mr. Flux might be able to get another index-number—an index-number which the League of Nations needs very much—namely, the index-number which will, in fact, reflect the purchasing power parities of the currencies of different countries. That is not Mr. Flux's present index-number. It is an index-number in which exports and imports and those things which may, in fact, influence the exchanges are included. I should like Mr. Flux to pick out from his new index-number, or from the material from which it is composed, the material for calculating that index-number which is the basis of exchange, because, after all, index-numbers may be used to record past history, but they will be still more useful and far more important for the economic life of the country if they can assist to solve the problems of the future. To-day it would be invaluable if you could have an index-number which would indicate the true purchasing power parity between country A and country B, based upon those commodities which can influence international trade. If that index-number could be established you would, perhaps, be able to eliminate a good deal of the speculative element which to-day is largely responsible for the fluctuations of exchange; if you can eliminate the fluctuations from the exchanges, the fact that they are at levels which we are not accustomed to is of no importance, and such numbers as I have referred to is one of the first steps towards producing that stabilisation.

Mr. PERCY WALLIS said it was so late that he would only make one or two remarks; but he wished to refer to an enquiry he had been making which dealt with the subject matter of the last paragraph of Mr. Flux's Paper. He claimed to have discovered the cause of price variation and could measure it so exactly that the price could be forecasted with great accuracy. He had for ten years been making forecasts of the price of cotton and the varying

error had only been a farthing a pound per year. In the few moments at his disposal he could give very little idea of the method, but he felt that a real measure of price was so urgently wanted that he rose to mention the fact that it could be done, and a record of the process was in course of publication. Copies of the published forecasts had been sent to the Library of the Statistical Society, so that any of the Fellows who liked could refer to them. Even during the war it had been possible to forecast with exactness what was going to take place and the price of such commodities as cotton correctly estimated. He therefore hoped the wish expressed by Mr. Flux in the last paragraph would soon be realized and not have to wait the indefinite time suggested by the way it was worded. He would be pleased to put the matter before Mr. Flux, or any other person who wished to enter into it. He wished to add his voice to the vote that had been proposed and seconded, and support the vote of thanks to Mr. Flux for his Paper.

Mr. NORMAN CRUMP said it was the first time he had addressed the Society, and he was particularly glad to have the opportunity on that occasion of supporting the resolution of thanks to Mr. Flux. He had known Mr. Flux personally for the last few months as well as by reputation, and he felt it was a very great honour to him to have that opportunity of supporting the resolution. A second point which particularly pleased him was that quite accidentally he had been working on similar lines during the past six months, and he thought it was only about three weeks ago that he discovered that after all he was simply following in Mr. Flux's footsteps. He also had come to the conclusion that the index-numbers based on prices prevailing before the war were, to some extent, at the present moment out of date. As one man had put it to him, it was rather like looking for his potato patch after an earthquake, to try to base index-numbers for the present day on pre-war prices. For that reason he had tried to work out an index-number based on the chain method which Mr. Flux proposed to introduce, and it was personally his opinion that his adoption of the chain index-number was one of the most important features of Mr. Flux's proposal. The only difference, he (the speaker) made was that, first of all, owing to his working single-handed, he had to use a small list which he weighted, and he admitted that he agreed with Mr. Flux in the criticisms he had passed on the use of a small list. The same applied to a geometric mean. He was forced to use an arithmetic mean owing to lack of time for computation of the geometric mean. There again he agreed with Mr. Flux's arguments in favour of the geometric mean. The chief point of difference he had made and one to which, on the whole, if Mr. Flux would excuse him, he was rather inclined to stick to, was that instead of using as his base the prices ruling for the corresponding *month* of the previous year, he took as his base the average prices ruling the whole of that previous year. To make it clear he worked out a whole series of index-numbers for various

months of 1920 which were all calculated by taking as the base the average price current for each commodity which ruled over the whole of the year 1919, and it was on that base of the year 1919 that he had worked out his various numbers for 1920. He had hoped to be able to give them some of those figures so that they would be able to see how the thing worked out in actual practice, but owing to the lack of time he did not propose then to inflict them upon them. If anyone cared to inspect them he had them; and he would simply content himself by saying that the total index-number starting in January at 130 ran up to 138 in April and since then had fallen to 102 in December, 1920, a hundred of course being taken as the average prices ruling for the year 1919.¹ He was not quite clear in his own mind as to whether it was best to base oneself upon the year or upon the month. He had made a rough calculation to see what the difference was, and had found that owing to the fact that prices, broadly speaking, rose steadily during 1919 and fell

¹ The following figures show the variations of Mr. Crump's index-number during 1920, expressed as percentages of the average prices of 1919 and of 1920 :—

(a) *Based on 1919 average prices.*

Month.	Food.	Materials.	Total index-number.	Month.	Food.	Materials.	Total index-number.
1920.				1920.			
January	113	139	130	July	121	132	128
February	114	146	135	August	111	131	124
March	113	148	136	September ..	113	128	123
April	119	148	138	October	113	119	117
May	121	144	136	November....	110	111	111
June	133	135	134	December....	106	100	102

(b) *Based on 1920 average prices.*

Month.	Food.	Materials.	Total index-number.	Month.	Food.	Materials.	Total index-number.
1920.				1920.			
January	96.3	101.9	100.0	September ..	96.4	96.3	96.3
February	96.5	109.5	105.1	October	97.8	90.1	92.6
March	99.3	111.5	107.4	November....	95.5	82.7	86.6
April	105.5	110.0	108.5	December	88.5	72.9	77.7
May	104.1	109.8	107.9	1921.			
June	102.9	104.4	104.0	January	84.1	66.9	72.1
July	100.0	101.0	100.7	February	78.8	61.6	66.8
August	94.6	99.7	98.0	March	76.9	56.1	62.2

Note.—Different methods were employed in computing these two index-numbers, and so there are certain discrepancies between them. The second group is the more accurate, and is being continued for 1921.

steadily during 1920 after the first few months of the year, if one based one's monthly index-number on the price ruling in the month exactly the year before, it increased twice as fast as if they took as their base the average price for the whole year. The reason of that was that the prices were going up in the base year and were coming down in the later year, and each effect added itself to the other. If, therefore, he could make a suggestion to Mr. Flux, it would be that he would like to see two index-numbers. Perhaps Mr. Flux might not be able to carry out both of them himself, and, if not, perhaps some other office or person might see their way to carry it out. One was based on the prices ruling twelve months before, as Mr. Flux suggested, and the other would be based on the average prices ruling for the whole of the year before. The second one would show whether the prices were actually falling or rising, and not that they were either falling this year or rising last year, each of which could produce the same result. It also might be clearer to the general business man to understand what was happening. If he might make a second suggestion, it would be to support a suggestion previously made that an explanation should be issued by the Board of Trade explaining exactly what was the object of the new index-number, and what it was trying to tell one and how it was arrived at. He believed a similar explanation was being issued in connection with the forthcoming census of production. What helped the one he thought might be expected to help the other. At the same time, with those exceptions, inexperienced as he was in those matters, he found himself coming to the same conclusions as Mr. Flux, and, in addition to that, he had succeeded in obtaining some figures to show how the thing worked out in practice. That was the chief reason for his wishing to take that opportunity of publicly supporting the motion.

Sir FRANK DYSON said that the only point on which he wished to remark was the use of the geometric mean. In physical and astronomical questions the arithmetic mean was usually employed. But this is a matter of convenience. There was no logical proof that the arithmetic mean is the most probable result of a series of measurements. The use of the geometric mean by Mr. Flux seemed justified because it gave the same result, whether one went forward or backward, and worked directly from one year to another or through intermediate years. In most cases the differences between the arithmetic and geometric means would be small—and he did not think the very slight additional difficulty or complication in the calculations need be considered.

Dr. L. ISSERLIS said he wished to associate himself with the others who had congratulated and thanked Mr. Flux for the paper he had put before them. He particularly wished to associate himself with those who had suggested that when a thing was too difficult for an individual to perform that was exactly the correct thing for a

Government Department, and particularly the Board of Trade, to undertake. It was not only in the case of index-numbers of commodities; there were other things which some of them had tried to do and the Board of Trade had done for them. For instance, the Board of Trade had told him what was an index-number for the cost of transport, especially the cost of transport on water. But there was one point with regard to which he wished to ask Mr. Flux, and that was what was the real bearing of his figures? He thought after the explanations not only of Mr. Flux but of the editor of the *Statist* and the editor of the *Economist*, he (the speaker) still did not understand what the index-number represented. It was running through his mind earlier that evening that there was a great danger in comparing things, in starting, say, with 1920 as a kind of new basis, when all the figures up to 1914 expressed wholesale prices in terms of money based on the gold standard. For all practical purposes the 1920 figures and the war figures were not on a gold standard. It seemed to him that the real meaning of the index-number was the price of gold, in terms of commodities. He was not sure whether he did not incidentally receive support for his suggestion by Mr. Macrosty's account of how he was able to check month by month the dollar exchange by comparing the index-numbers. One other point on which he wished to touch was that he was not sure whether mathematicians, as such, had any right to say anything about the advantages of one particular mean over another. He fully thought that no mean had any special justification as being the best mean. The only thing he saw in favour of the geometric mean was, that it did give less weight to very big jumps, but it was not always the case that the difference between the arithmetic mean and the geometrical mean was very small. To do a little mathematics before he finished, the arithmetic mean of 2 and 8 was 5 and the geometric mean of 2 and 8 was 4. That he thought was in favour of the geometric mean. If before the war anything from 2 to 3 represented the price of a certain commodity, and war conditions had rushed that commodity up to 8 while others had not rushed up anything like that, he thought it was fair to put it at 4, and that was the geometric mean. Only practical considerations of this kind should be used in justifying the change from one kind of mean to another. He did not think it was right to suggest that one particular mean had a better mathematical basis than another.

The CHAIRMAN said that reference had been made to the interests of Labour as affected by the particular question before them; and as they had the advantage of representatives of Labour being present, they would be very pleased if either of them would take part in the discussion.

Mr. H. L. TRACHTENBERG said he wished to answer Dr. Isserlis on the question of the geometric mean. He was surprised that a mathematician of his ability should agree that there was not much

difference between the geometric and the arithmetic mean, for the following reason. He thought Dr. Isserlis would agree that in homogeneous data it was proved by the method of least squares that the type of errors in observation were such as give the best result in the arithmetic mean. In the prices index-numbers they were not dealing with homogeneous data, but were combining a number of market prices which were heterogeneous. He, therefore, did not see any objection to the more convenient plan of using the geometric mean. Had it not been for the fact that they were heterogeneous he would have strongly insisted on the arithmetic mean being adopted. Apart from expressing his pleasure at Mr. Flux's Paper, the only other point he wished to refer to was Mr. Layton's suggestion about the League of Nations. If they were going to have things done on a common basis, the measuring of price changes in various countries would be an important thing in consequence of that idea, and he had no doubt Mr. Flux would consider that point; but he would not like him to sacrifice any of the excellent suggestions that underlay his method, because he considered that his number was an improvement on the old number and brought the science of index-numbering to as practical and correct a point as could be attained; but if he could possibly get other countries to come in with him, that would be a great point in favour of seeking co-operation.

MR. GEORGE DALLAS said he was very pleased to have the invitation to be present at that most interesting discussion. As a representative of Labour he might say frankly the discussion was one of a very technical character to one who was not initiated into the science of statistics as most of them were. But he felt certain that the results of a discussion of that character would be of great value to Labour. Those of them who were negotiators and who were meeting employers almost every day in the week or every week in the year, had to rely very definitely on the figures produced by the Board of Trade; and as one with considerable experience he might say frankly he had had to fight some very hard fights over the statistics produced by the Board of Trade. He had seen them challenged time and time again by first one side and then the other. He had known Labour say that the cost of living, as shown by the figures of the Board of Trade, was not correct and that the cost of living had gone up much higher. He had heard the employers say they were not accurate because the cost of living had not risen so high. But they were extremely indebted to the Board of Trade and its officials, who were rendering great service not only to the employers or to Labour, but to industry as a whole in producing the figures it did. If any new system would produce more accurate figures, or figures which would be satisfactory to both sides, he was quite sure it would have a very beneficial result in preventing a large amount of friction which had taken place in the past because the figures had been challenged either by one or both parties.

The PRESIDENT said he thought the time which they had reached indicated the interest which had been taken in the subject, and they were at any rate all agreed it was not only most important but extremely timely. He would not attempt to add any words to the discussion. Owing to his absence from town the last two or three days, he had not had the advantage of reading the paper until he had got there that evening, so that even if there were time he would not in the least presume to make any observations on so important a subject without some time for consideration. He would, therefore, at once put to them the vote of thanks which had been moved, seconded and supported.

On the vote of thanks being put to the Meeting it was carried unanimously.

Mr. FLUX, in reply, said he was indebted to the Chairman, and to those present for the patience with which they had listened to a rather long paper. He was not going to attempt to thrash right through the points which had been raised. There were, however, one or two to which he wished to refer in passing. Mr. Yule had raised some matters of very great importance. One was the question of the distribution of the price movements. He would say that he had operated on a different series from that upon which Mr. Yule had been engaged. Mr. Yule had been operating on relatively small numbers which he derived from the Sauerbeck index. Most of his (Mr. Flux's) operations had been conducted with the 250, or thereabouts, numbers derived from the reports of the Washington Bureau of Labor Statistics. He had found that there was some coherence in the figures, and they did not tend to show so great a similarity year by year in their distribution as Mr. Yule had suggested. He thought possibly the lack of evidence of definite tendencies to types and form might be due to the narrowness of the range Mr. Yule was using. He was, however, not disposed to push further with the Bureau's data, because they included such a very large number of items such as saws, axes, adzes, and other goods of that sort, the indications of whose price changes in the wholesale markets did not seem to him to have a right to be put on the same level as the variations in the price of cotton, wool, wheat, or other great staples. He had therefore hesitated to accept at its face value the apparent evidence of the grouping. Mr. Yule had also raised the question of why they were not going to take the whole of the 150 numbers and take their simple average. There were two or three reasons why they were disposed to average group figures rather than all the items directly, although he might say it was a matter which still remained to some extent open. At present his idea was that the groups had been so arranged as to be so nearly equal in importance as would justify the ignoring of their divergences from equality. If that were done they would have a greater freedom in dealing with details within the groups, perhaps expanding

the number of quotations they used if it were found convenient, so as to get the best possible indication, as time went on, of the course of events, without in that way preventing themselves from combining the results of the groups on a basis of equality. There would further be a good deal of interest in the independent results of the groups. So that there was a reason for compiling eight such groups and setting out the results independently. Having compiled them, a complicated combination seemed hardly worth while, and a simple combination into the aggregate index-number, if it did not lead them really astray from the straight path, was yet reasonably commendable. Then both in view of what Sir George Paish and Mr. George Dallas had said, he would add to what Mr. Macrosty had stated, and, if he could, would dispel the delusion that the Board of Trade index-number was the same as that index-number of the cost of living which was being constantly quoted in reference to wage movements. It was not the same thing and was not compiled from the same data. In future it would not be compiled in the same manner, and it was to be discriminated from the other in almost every possible way. The Board of Trade was concerned with the movements of the wholesale markets. The Ministry of Labour compiled a number indicating the effect of changes of prices upon those people who bought retail, and the two things were not the same. The number that was quoted in most labour arguments was the retail prices index-number. It was the Ministry of Labour's index-number. It was at one time a Board of Trade index-number because there was one Ministry which covered both the present work of the Board of Trade and that of the Ministry of Labour; but since the two Ministries had been independent it had not been the Board of Trade index-number, and was not at that moment the Board of Trade index-number. He thought it would tend to clearness if those who guided public thought in that matter would endeavour to keep in mind that when they referred to the Board of Trade index-number, meaning the retail price index-number, they were actually referring to a different thing from that to which they intended to refer. Then Mr. Layton had suggested that one would find a good deal of difficulty in securing market quotations instead of the import and export average values which they had at their disposal. They thought they saw their way to getting almost, if not quite, the whole of the 150 series that were set out in Appendix II. They thought they might in certain directions get more. They might find, in practice, that the numbers could not be maintained over a long series of years; and that had been, he would say, one of the reasons which had led them to prefer the year-by-year step method, so that they might not be hampered at any time if they found that a series of market quotations that served to indicate the trend of a given market at one time could not be obtained any longer because of the particular article concerned having no longer the same importance in the market, and that some other article of the same general character had now great importance and could be given and they could introduce it on the year-by-year step method

with great facility. It was for that and other reasons that they found the geometric mode of averaging was so appropriate a method. In the work he had done upon the Bureau of Labor Statistics indices, he had taken the trouble some thirteen or fourteen years before to work out the year-by-year steps on the basis of arithmetic averages as well as geometric averages ; and he might say that the arithmetic averages, as everyone knew by looking at the simple mathematics of the problem, invariably showed a larger result than the geometric averages. This means, with rising prices, that the arithmetic average rises faster than the geometric, and with falling prices the arithmetic average falls more slowly than the geometric. Thus the figure resulting from year-by-year steps based on arithmetic averages will tend to be higher than that resulting from the use of geometric averages. He did not think that was altogether an advantage, and it was rather a remarkable thing, and that was why he had set out the figures in Appendix III, that the geometric average applied straightforwardly gave them results corresponding very closely to those reached by the method of reference to a fixed date and arithmetic averages which the Bureau followed. With regard to other countries and comparability, he thought that there were several points to be borne in mind. If all countries were able to utilise the same methods, it would be desirable that they should do so. By that he did not mean that they should use exactly the same material ; and he very much feared that there were some indices compiled in other countries that had been compiled by a somewhat unintelligent use of the list of articles employed in the compilation of the *Economist* index-number. Whether that basic list of articles really reflected the commercial activity of the communities to which it was going to be applied as well as it did the commercial activity of our own country or not, he did not think they needed to have the series of numbers compiled on precisely the same model in order to get good comparable results for the international purposes that had to be served. Then if they needed to compare results compiled in the same sort of way, that was to say arithmetic averages, and the *Economist* continued to compile its admirable arithmetic average and the *Statist* and *The Times* also, the means of getting numbers which might be compared quite fairly with arithmetic averages of 40 or 50 series of prices in other countries he thought were at their disposal, and if they wanted to do something that went beyond that, there was no great virtue in presenting a different series of quotations on precisely the same procedure of averaging. It was necessary for the work of the Board of Trade that the course of price movements in a wide range of markets should be placed on record in order to be available for reference when they were wanted, and that meant that it was necessary that they should keep a very large part, if not the whole, of the records that would be necessary to serve as basic material for that index-number, and the compilation out of that mass of material of a new index-number might reasonably, if taken up, be taken up with a view of introducing a variety in procedure, unless that variety

in procedure was objectionable in any particular way in itself. He thought he might reasonably gather that most, if not all, of those who had spoken that evening—he thought even Mr. Layton agreed with him there—had not found anything objectionable in itself in the use of the geometric average for the purpose of combining such a mass of results as that; and even from Mr. Layton's own remarks he would suggest that, as he desired to emphasise the fact that wholesale price indices were not measures of purchasing power, if the arithmetic average mode of procedure were adopted it was more difficult to maintain the thesis that they were not measures of purchasing power than if the geometric average was used. The fact that it did not seem to mean anything concrete to the ordinary mind he hoped might enable them to insist upon the point that Mr. Layton so well made and made with such justice. Those were some of the reasons but by no means all the reasons that had been in their minds. With reference to market quotations as against import and export prices, Mr. Layton had told them, and he thought quite rightly, that market quotations of materials expressed anticipations of what was going to happen in the various lines of industry. It was just because he thought that they did express an effort to look into the future, and that, consciously or unconsciously, they expressed the anticipations of the immediate future of manufacturing prosperity, that he had suggested that the study of the distributions might enable them to see and to crystallise in terms of some few figures what the various groups of manufacturers and merchants, independently of one another, were on the whole expecting to realise. It was because he regarded market prices as looking to the future and as crystallizing an anticipation of the future, and not merely expressing the bid of the moment for a given article, that he had expected that something on the lines of the last paragraph of the Paper would be possible when the appropriate material for compilation and analysis became available.

The following Candidates were elected Fellows of the Society:—

Capt. Ralph Bower Ainsworth, M.C.
 Sir George Lewis Barstow.
 James Brace.
 Dr. Burdette Ross Buckingham.
 Major Ernest A. C. Belcher, C.B.E.,
 M.A.
 Arthur Collins.
 Francis Peabody Croshaw.
 Professor Edmund Day.
 Sir Henry James Gibson, K.C.B.
 William G. C. Hanna.

Sir Richard V. Nind Hopkins, K.C.B.
 Cadwaladr Brymer Jones.
 Herbert Locke.
 Professor Douglas Knoop, B.A.
 Edgar McWilliam, B.Sc. (Econ.).
 Jaikrishna Nagardas Varma, B.A.,
 LL.B. (Bom.).
 Robert J. A. Pearson, O.B.E., M.Sc.
 Thomas Williams Phillips, C.B.E.
 Sir David James Shackleton, K.C.B.
 Marcus Loftus Woodhouse, A.I.S.A.

Corporate Representative.

George P. Warner Terry (*representing* the British Waterworks Association).