The Practical Interpretation of Index Numbers

by

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Most of the criticisms and discussions of price index numbers which have been published in recent years have been concerned mainly with questions of formula and method, and to a very small extent with materials. The last of these, however, is of prime importance, and failure to appreciate the real meaning of the quotations used for the various items which go to make up an index number may result in quite unjustifiable deductions from the final figures. This is illustrated below by examples drawn mainly from the leather industry, which suffice to show the practical difficulties in the way of choosing a quotation, even for a single commodity, which shall be really representative either of conditions in the industry or of the prices actually paid, either at a given date or for goods for consumption at that date, and which is not misleading on account of seasonal or other variations in quality or condition of the goods in question, or of confusion between speculative and industrial purchases. The author suggests that a system of separate indexes of prosperity might be constructed for all important industries, and that these might be combined into a general index of industrial prosperity, which would then usefully supersede the present price indexes for purposes of industrial discussions.

INDEX numbers of prices are used for such a variety of purposes at the present time and inferences frequently carrying with them consequences of such far-reaching effect are made from them that it has become a matter of importance to enquire to what extent the foundations upon which such indexes are based will support the conclusions which it is attempted to draw from them.

The criticisms which have been published in recent years regarding index numbers have been concerned almost entirely with the question of " formula and method " and only to a very

small extent with the question of " material ". In his monumental work on *The Making of Index Numbers* Professor Irving Fisher, in a volume of over 500 pages, gives only the most meagre account of the nature and value of the data on which published index numbers are based, though dealing at considerable length with deficiencies in the formulæ used. Important as it is that the formulæ should be logically and mathematically correct, it is for practical purposes probably almost more important that the material used should not merely be the best available but really representative of the facts concerning which it is desired to make deductions. The architect's part in building a house is no doubt of great importance, but most people would prefer that his work should be imperfect rather than that defective bricks, mortar, and timber should be used for carrying out the plans he has evolved. This paper, accordingly, attempts to bring into proper perspective the part played by " material " as distinct from that of " formula " in the production of an index number, and by illustrating that the " material " is frequently defective to sound a warning against the hasty use of index numbers for purposes for which they were never intended and for which in their present forms most of them are unsuited.

It cannot be too strongly emphasised that the sole purpose for which index numbers of prices were originally devised was that of the determination of a mere statistical average. This foundation, however, is frequently lost sight of and it would probably greatly surprise our statistical forefathers to read the deductions which have been drawn in recent years through the media of index numbers. It is interesting in tracing the history of price index numbers to note that the interest created in these and the development in their construction and application were always greatest in times of fluctuating prices. These are the times when there is greater need for ascertaining the average of movements of individual prices. When prices are steady there is the less need for the determination of such an average, but when certain prices are moving rapidly there is a natural inclination to enquire what is the average movement. If a group of men were all obviously of the same stature the question of measuring them all in order to ascertain their average height would probably never arise, but when there is clearly substantial variation the question of determining the average naturally arises. Professor Wesley Mitchell has pointed out that the period of the Napoleonic wars, during which prices fluctuated violently, was one in which the theory and practice

of index numbers was considerably developed. Subsequently, however, interest in the subject flagged until, with the discovery of the Californian and Australian goldfields, prices moved rapidly again, and then there was renewed interest in the determination of an indication of the average movement. Later on, in the 'seventies of last century, when prices began to fall interest was again stimulated, while the violent movements in the past decade have caused quite a boom in the study of prices; but it may be predicted that interest will flag again as soon as a more or less steady level is reached.

The primary object which the early economists had in working out an index number was a mere statistical one, and was not that of ascertaining reasons for movements in prices or the state of activity of industry or a measure of currency in circulation. As certain of the best known index numbers, notably those of the London *Economist* and Sauerbeck, are of considerable age and the method of compilation has not greatly varied throughout the long period, it is no reflection upon the value of these indexes for the purpose for which they were primarily devised that they do not, in the opinion of many, support the conclusions which others now attempt to draw from them.

An index of prices demonstrates very little more than does a measure of the average height of a population. A comparison of the average height of two populations records definite statistical facts; it does not, however, enable us to deduce with safety other facts. It may be true, as has been suggested. that the death rate from phthisis among tall people is greater than the death rate among short people. Even if it be true, however, the fact that one particular population may average 5ft. 10in. and another may average 5ft. 6in. does not justify the deduction that the death rate from phthisis in the former population is greater than that in the latter. This form of argument, however, is comparable with that which, after having shown that the index number of prices has risen during a period of active trade, subsequently attempts to deduce from the fact that the index number has risen between one month and the next that trade is necessarily improving. If the science of index numbers is to retain its repute and is not to suffer like the common tipster through the failure of the predictions which enthusiasts claim to make by its aid, it is fundamentally necessary to appreciate the foundation on which index numbers are built and the limitations which are essential to their proper use.

The British price index number which lends itself most easily to criticism is the " Sauerbeck ". The reason for this is not that it necessarily contains more deficiencies than other indexes but that fairly full details regarding it and the data on which it is based are published annually in the *Journal of the Royal Statistical Society*. It is natural, accordingly, to illustrate the point of view developed in this article by reference to that index. The writer's connection with one British industry in particular provides also the explanation that many of these illustrations have reference to the leather industry.

It may be said generally that until recent years the method of compilation of index numbers has followed the line of least resistance. Price quotations which are readily available and which involve no trouble in their use have been employed, whether or not they are appropriate. To some extent perhaps this is inevitable, but the fact should be clearly recognised. It means that, strictly, an index of prices is a form of average of those prices which are readily obtainable and not necessarily of those prices which are really important in industry. In certain of the British index numbers, for example, it would appear that much reliance is placed upon quotations obtained in the City of London. Great changes have come over industry and commercial organisation in Great Britain, however, in the decades since those index numbers were first published. Though still representing possibly an index number of price quotations in the City of London they no longer afford (if they ever did) an adequate representation of certain of the facts of British industry. In the Sauerbeck index, out of a total of twenty-six quotations employed in the production of the index number for materials, five relate to hides and leather. If a new index number were to be started in our present state of knowledge and under the best advice, four of these would certainly not be employed. Two are definitely misleading, one is quite unrepresentative in the form used, while the fourth lost any real significance it ever had years ago. For the purpose of appreciating the inapplicability of the quotations used in some index numbers as a reflection of industry more detailed reference may be made to these quotations. It may possibly be that the amount of criticisms which can be made in respect of the leather and hide quotations is disproportionate to that for other industries, but every industry has its idiosyncrasies, and it is probable that other industries could make similar criticisms. The only actual price quotation used for leather in the Sauerbeck index is that for " dressing

hides ", and presumably the figures used in compiling the index are those published weekly in the *Statist*. At no time could these have been really representative of leather prices, and at the best they only cover a very small proportion of all the various classes of leather. It is worth while, for the purpose of appreciating the value of the data used, to examine the course of the quotations published for this commodity over the past two years. The weekly quotations have been as follows :

SELECTED PRICE QUOTATIONS FOR LEATHER, 1922-1924

Period	Extreme prices per lb.				Number of successive quotations	Mean price	
	Minimum		Maximum				
	s.	d.	s.	d.		s.	d.
Aug.-Oct. 1922	1	10	2	6	12	2	2
Nov. 1922-June 1923	1	9	2	3	37	2	0
July 1923	1	3½	2	6	2	1	11
Aug. 1923	1	9	2	3	1	2	0
Aug. 1923	1	6	2	0	3	1	9
Sept. 1923-May 1924	1	9	2	0	37	1	10½
May-July 1924	1	4	2	6	10	1	11

A price quoted between such wide limits is almost meaningless. It is not known what figure — highest, lowest, or average — is used in compiling the index, but whichever it is it is certainly unsatisfactory, to say the least. Nothing of significance can be deduced from a quotation in which the lower limit *falls* in a week by 5½d. (26 per cent.) while the higher limit *rises* by 3d. (11 per cent.), while a fortnight afterwards the reverse movements are recorded. Even if this quotation was intelligible it would be of little value, as there is no relation at all between the price of this class of leather and that of leather required for boots (a form of consumption at least twenty times as important as that quoted).

Five of the twenty-six quotations on which the index for materials is based are derived from " average import prices ". These quotations can be obtained with practically no trouble at all, as it is only necessary to take the monthly Official Statistics of Imports and divide the quantity into the corresponding value. Not only is the result, at any rate in the case of hides and leather, frequently quite different from that given by the use of true price quotations, but it is open to serious fallacies, e.g. if more than the average quantity of upper leather is imported one month while less than the average quantity of sole leather is imported, the quota-

tion for " leather " would go up even though the price of each single variety had remained unaltered. The reason for this is that the price of upper leather by weight is much higher than the price of sole leather by weight. In the case of hides, owing to the fact that inferior hides are imported in a particular form which has the paradoxical effect that the price per cwt. is higher than the price per cwt. of better class hides, the use of an " average import price " covering both varieties would create the impression that prices had risen, when the fact might be that an inferior article was being used. An instance has been noted[1] in which the " average import price " between one month and the next showed an *increase* of 21 per cent., while the movement in actual prices in the same period was a *fall* of 2 per cent. The effect of the use of " average import prices " in the production of an index number was summed up in the following words : " It would appear that a variation of 4 per cent. (equivalent to five points) in the final Sauerbeck index number for materials might arise even though there was no actual change in prices. In other words, without an examination of the contributory statistics we cannot be certain that a movement of less than four or five points in the Sauerbeck index for materials is indicative of a significant movement in prices from one month to the next ."

The case of hides illustrates another point which it is important to bear in mind if the index number is to be used for the purpose of true inferences regarding the state of industry. Without some knowledge of the trade in the commodity which is quoted it is almost impossible to appreciate the meaning of a price quotation. In the case of those materials which are derived from an annual crop there are difficulties in the way of getting comparable quotations about the time of passing from the old to the new crop. Every commodity probably has its own peculiarities, and the amount of correction necessary to allow for these may vary in different cases. In the case of hide quotations, the correction necessary may be substantial, due to failure to take account of variation in quality from season to season of the year. A hide when purchased by the tanner has on it hair and dirt which vary in amount according to the season of the year, while other features also vary in a similar manner. As a consequence of the operation of these factors, if the average value of a native hide in Great Britain to the

[1] Cf. *Journal of the Royal Statistical Society*, Vol. LXXXVI, May 1923, p. 348.

tanner throughout the year is taken as 100, the value of the hide coming forward each month is as follows :

January	93	July	108
February	93	August	108
March	93	September	106
April	95	October	105
May	100	November	102
June	105	December	97

Thus, if the price quotation was the same in January and in August, the actual fact would be that his actual raw material was costing the tanner 15 per cent. more in the earlier month than in the later one. It follows that in order to get a comparable series of price quotations correction should be made each month in the actual prices quoted. The corrective factor will, however, vary in different countries, and will tend to operate in the opposite direction for hides from countries in the Southern Hemisphere from that for hides coming from countries in the Northern Hemisphere. There are also further complications which need not be mentioned here. The upshot, however, is that when a " corrected " hide index number is determined, making allowance for as many of the factors operating as possible, the true index compares with the indexes obtained by using the same sources of data as the Sauerbeck Index as follows :

MONTHLY INDEX NUMBERS OF HIDES FOR 1923

(Average for 1923 = 100 in each case)

Month	Corrected index	Index based on			
		River Plate dry hides	River Plate salted hides	Average import price	Average of columns (2), (3), and (4)
	(1)	(2)	(3)	(4)	(5)
Jan.	104	103	106	102	104
Feb.	104	103	106	106	105
March	101	103	106	108	106
April	104	108	108	102	106
May	104	106	105	104	105
Juue	104	103	108	98	103
July	100	96	100	107	101
Aug.	97	96	97	103	99
Sept.	95	95	90	97	94
Oct.	96	98	95	96	96
Nov.	96	96	93	89	93
Dec.	95	90	84	94	89

For the purpose of indicating what the circumstances of the industry fix as the relative values of hides from month to month the "corrected index" shown in the first column is probably as close to the truth as it is possible to get. There are substantial divergences between the figures given in the first column and those in any of the others. The circumstances of the industry determine that the price which could be paid by a tanner at the end of the year was 9 per cent. less than at the beginning. The corresponding reductions as indicated by the indexes referred to in columns (2), (3), and (4) were 13 per cent., 22 per cent., and 8 per cent. respectively, while the figure determined by the average of these showed a reduction of 15 per cent., and this is approximately what the Sauerbeck index would have shown. The importance of a thorough overhauling of the data used in the construction of price index numbers will be manifest from this illustration.

It would appear that the data for a price index number to be used for industrial purposes could best be obtained from the organisations representing the different industries, who should treat the data so as to allow for the operation of factors such as those referred to above. It is not easy for those organisations to take the responsibility of publishing such data. In the case of the tanning industry in Great Britain, for example, the organisation concerned—the United Tanners' Federation—has compiled an index of hide prices which is certainly a great improvement upon any material used in the compilation of general index numbers in that country. It is subject, however, to certain imperfections and the Federation accordingly hesitates to make the figures public. The consequences which might follow through the publication of an index number by a trade organisation are very wide, and it is essential that anything published in this way should be as close to the ideal as it is practically possible to get. It is possible, however, that shortly the United Tanners' Federation will undertake the responsibility of publishing its hide index number. In the case of leather, however, the difficulties in the way of drawing up a satisfactory index number are so great that it is unlikely that any index can be published through the same channel, even though the data used in the indexes published are extremely imperfect.

If real progress is to be made in the science of index numbers the importance of getting the data for the general index number from the industrial federations concerned cannot be too highly emphasised. An index number based upon data furnished by about ten of the main industries of a country would be of much greater

value, for the purpose of throwing light upon the state of industry, than an index based upon forty price quotations obtained from the sources at present open to compilers of index numbers. The index number issued by the former Imperial Statistical Office of Germany was based entirely upon information supplied by trade organisations. In Great Britain, however, no attempt has been made to found an index on this basis. The need of it may, however, be emphasised by another illustration drawn from the leather industry, a passing reference to which has already been made. Three well-defined classes of hides are used in the production of leather, the distinction between them arising from differences in the method of cure. The native hide is purchased in such a state that the tanner obtains about 100 per cent. of leather substance (known as " pelt ") from a given weight of hides. Some hides are imported in the " wet-salted " state and these will give about 80 per cent. of their weight in pelt. The remainder are imported in the " dry or dry-salted " state, and will produce at least 160 per cent. of their weight in pelt. In quality of leather produced from them, the third class is inferior to the others, and the finished leather is accordingly cheaper. In 1923 there was in Great Britain an increased demand for this leather in the place of leather from " wet-salted " hides. The position can be summarised by showing the first and last items in a table published in the paper in the *Journal of the Royal Statistical Society*[1] previously referred to.

IMPORTS OF HIDES INTO GREAT BRITAIN

Month	Dry and dry-salted hides		Wet hides		Total		Price index
	Quantity	Price per cwt.	Quantity	Price per cwt.	Quantity	Price per cwt.	
	cwt.	£	cwt.	£	cwt.	£	
1921 Sept.	26,360	3.78	76,550	4.23	102,910	4.12	100
1923 Feb.	63,950	4.07	35,320	3.60	99,270	3.91	95

It will be noted that while the imports of dry hides increased considerably the imports of wet hides fell equally. The dry hides

[1] May 1923, p. 345.

increased in price by 8 per cent. while the wet hides fell by 15 per cent. Combining the two in the way used for the Sauerbeck index a fall of 5 per cent. only in price was indicated.

If, however, the same figures are expressed in terms of the manufacturers' real raw material, namely, "pelt", a quite different result is forthcoming. The corresponding figures to those set out above are as follows :

IMPORTS OF HIDES INTO GREAT BRITAIN

(*Expressed in terms of "Pelt"*)

Month	Pelt from dry and dry-salted hides		Pelt from wet hides		Total pelt		Price index
	Quantity	Price per cwt.	Quantity	Price per cwt.	Quantity	Price per cwt.	
	cwt.	£	cwt.	£	cwt.	£	
1921 Sept.	42,180	2.36	61,240	5.29	103,420	4.11	100
1923 Feb.	102,320	2.55	28,250	4.50	130,580	2.96	72

These figures show a considerable increase in the quantity of leather-producing substance imported in the later month, though in the uncorrected figures the movement was shown in the opposite direction. The price of this substance, however, actually fell by no less than 28 per cent., as compared with 5 per cent., the figure indicated by the original data. This substantial fall was not entirely due to reduction in price of a commodity used in equal quantities in the two periods, but to the fact that a change took place in the quality of the article used. This brings out a further point which should be borne in mind in the interpretation of index numbers. An index number for a particular country will tend to go up if the population in that country is tending to use higher-class articles. During the war period and for a year afterwards in England the demand was mainly for high-class articles. Subsequently the pendulum swayed rapidly the other way and the demand was for the cheapest possible article. The operation of this factor has important bearing, for example, on the relative prices of crossbred and merino wool, and on linen and cotton goods. In order to get a final index which shall really be sensitive to changes in the state of industrial prosperity it is essential to free the original data of

all entanglements which tend to hide the truth. The complete overhauling of the original data is the most vital necessity for the construction of a trustworthy index, and so specialised have industrial economics become that it would seem that this can only thoroughly be achieved if the expert organisations in each industry can be persuaded to assist in the work.

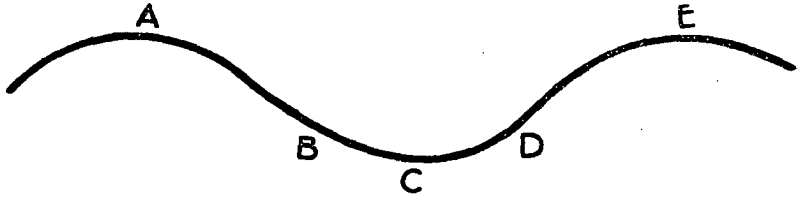
Another point of considerable importance to bear in mind in the practical interpretation of a price index number is the fact that the price quotations used in its compilation refer to industrial circumstances at widely varying dates. If an index number is to be used for the purpose of throwing light upon the state of industry the data for the various commodities should refer to industrial transactions carried through at the same time. It is obviously confusing if an index is based on quotations in respect of, say, cotton, for which the cotton manufacturer negotiates the purchase in June, hides, for which the tanner negotiated the purchase in March, and flax, for which the manufacturer negotiated the purchase in January. Yet this is what all index numbers do to some extent, and some index numbers to a considerable extent. As an illustration reference may be made again to the British Sauerbeck index number. The quotation given as the " average import price " of hides in, say, June, relates to transactions which were carried through possibly many months before. It is quite likely that some of these hides imported in June resulted from negotiations entered into four or five months before — in February or March — and in these negotiations the buyer was moved by his view of the state of industry at *that* time. In the case of Russian flax, owing to the fact that export is not possible in the winter months the goods imported in June might have been the subject of negotiation in the previous January, and the manufacturer was moved in fixing his price limit by the state of industry at *that* time. The quotation for American cotton, on the other hand, on which the June index number was based, depended upon the buyer's view of the state of industry in *that* month. Thus, in compiling the index number the facts which were in one buyer's head regarding the state of industry in January were mixed with the ideas which were in another's head with regard to the state of industry in March, and with another's for June. It should be fairly clear that no reliable conclusions as to the state of industry generally can be drawn from a conglomeration of notions and figures built up in this way. The illustration given is, no doubt, exceptional. But even index numbers which are not based upon " average import prices " are subject to the disability

to a certain extent. Each commodity is subject to its own special circumstances. A commodity which can be delivered promptly after the negotiations for a purchase have been completed is in a different category from one which is bought for shipment from the other side of the world. The purchaser of the former may be moved by quite different views of the state of industry from the latter. This is manifest by the fact that for the same commodity there is frequently great difference between prices for goods "on spot" or "afloat" and those "for shipment". In active times the former may be well above the latter, but frequently, and particularly in the past few years, the reverse has been the case. In certain index numbers — the official one for Germany, for example — quotations relating to hides and leather carry substantial weight in the determination of the final index. Tanners obtain their hides, however, both from native and imported sources (in the case of Great Britain in the proportion of approximately 1 : 2). When buying native hides the tanner will probably get delivery in a few days. Some months may elapse, however, after negotiating a purchase before he can get possession of the imported hides, and as the tanner, when buying the hides, has to attempt to forecast the state of the leather market at the time when the hides for which he is negotiating are converted into leather (which may involve a further period of from four to eight months), he may be moved by quite different circumstances when buying native hides from those on which his judgment is based when purchasing hides to be imported. The curves representing the two series of prices (even when corrected in the manner previously referred to) are frequently far from parallel. Thus the combining of two series of price quotations to produce a price index for a single industry may produce a result which would throw no light upon the buyers' views of the future of the state of industry, but might actually conceal the proof contained in each of the separate series.

An index number designed to throw light upon the state of industry should be based, if possible, on transactions actually made for industry as distinct from quotations relating to mere speculative business. In certain of the British index numbers prices of rubber and tin, for example, are employed. These are both articles of importance in industry, but they are also articles in which there is a great deal of buying and selling on the part of people who are in no way concerned with the manufacture of the goods. The same is true also in the case of cotton, the difference between rubber and cotton being that the speculation in the former

is very largely amateur, while in the latter it is carried on on professional lines. In either case, however, it is the fact that the amount " bought " and " sold " is very much greater than the amount consumed : in the case of rubber it has been reliably stated that the amount of rubber actually consumed in England is but a small proportion of the total amount bought and sold by those speculatively interested. The price quotations used are those quoted in the Mincing Lane market, and there is no means of knowing which quotations relate to purchases for consumption and which to speculative purchases. The speculator in June may buy for October-December shipment hoping that he may by the time shipment is made resell at a profit, or he may sell for the same shipment, hoping that he may be able to buy later at a lower price to fulfil the contract. In recent years he has very frequently been wrong, and ultimately when the material has arrived the man who can actually consume it has been able to get it at a price well below that originally quoted. Apart from this consideration the actual consumer is probably often in a position to buy at a favourable moment of the market and it may well be that in a cycle of price movements the higher prices are of little significance compared with the lower ones so far as purchases for consumption by manufacturers are concerned.

Quite apart from the question of speculative purposes there is some reason to believe that in the case of a number of commodities the manufacturer fills up his stocks mainly at the lower prices. This point is one of considerable importance and it is unfortunate that there are practically no statistical data bearing upon it.



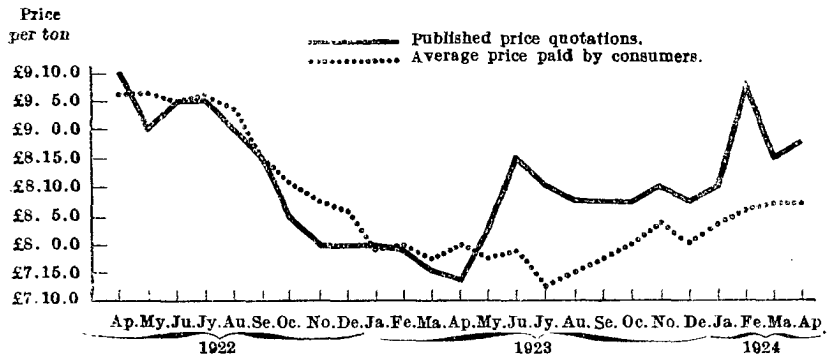
If the curve ABCDE represents the movement of prices of a commodity orthodox theory requires that when a small increase in price occurs (represented by C to D) consumers anticipate that a further increase will follow and by buying themselves in anticipation of the further increase actually help to produce the rise indicated by D to E. It may be that speculative buying follows this rule, but it is far from being proved that actual purchases for

consumption by manufacturers follow it. The writer's own view (based however chiefly on experience of only a few commodities moving between fairly wide price limits) is that the manufacturer, appreciating the futility of attempting to make his complete purchase at the bottom of the market, tries to commence buying before the lowest point is reached, i.e. at B, and is satisfied if he can cover his requirements within the range represented by B to D. His ideal would then be to hold off until a similar position is reached in the next cycle, and there is some reason to believe that the manufacturer, at any rate in recent years, has been remarkably successful in achieving this. If this view is correct, and it is rather more than a mere view, the portion BCD of the curve of prices is much more important than any other from the standpoint of industry, and an index number which gives as much weight to the other portions of the curve as to the portion BCD is not a proper means of deducing the state of industry. If the index number is to be used only for the purpose of reflecting the state of industry the ideal would be to weight the price quotations by the magnitude of the purchases made for industry (as distinct from merchant or speculative purchases) at those prices — a quite impossible ideal at present. The extent to which in its construction a price index number is removed from this ideal is a measure of its deficiency as a means of throwing light on the condition of industry, though it may be an admirable index for other purposes.

Although not of relatively great importance an example of the foregoing remarks may be given. The chief tanning material used in England and in Germany is wattle (bark and extract) imported from South Africa. It has been possible to obtain the figures of actual purchases by large consumers in England covering probably nearly 75 per cent. of the total business. The great bulk of this is done for " forward shipment ", i.e. the tanner may purchase in June, if he thinks the market is favourable, for shipment in November and December. If he considers the market is very favourable he may purchase very heavily for forward shipment and cover his requirements for many months ahead. If the market is unfavourable and continues unfavourable he will probably wait and then buy for prompt shipment just sufficient to cover his immediate requirements and continue this until in his view the market becomes favourable again. The quotations published and available for use in connection with this article relate chiefly to " prompt shipment ", and it is of interest to compare the curve of prices provided by these quotations for prompt shipment in a

particular month with the prices actually paid by those consumers who have bought bark to be shipped in that month. In the diagram below the continuous line shows the course of the price quotations monthly from January 1922 to June 1924, and the dotted line shows the average prices paid by consumers (75 per cent. of them, approximately) for bark shipped in each month during the same period.

COMPARISON OF PUBLISHED PRICE QUOTATIONS AND PRICES PAID BY CONSUMERS FOR WATTLE BARK, 1922-1924



The illustration is not a particularly good one, but as it is of a type which the writer has not hitherto seen published it has been reproduced. It illustrates the fact that there may be considerable divergence between the prices of actual purchases for industrial consumption and the prices publicly quoted. From the experience of April 1922 to April 1923 it would appear that prices for consumption were actually greater than prices publicly quoted, but that period was an extremely abnormal one. The exports (for practical purposes the same thing as the supplies available), which in 1913 were 65,000 tons and in 1919, 1920, and 1921 were 57,000 tons, 70,000 tons, and 71,000 tons respectively, suddenly jumped in 1922 to 121,000 tons. Both buyers and sellers were surprised at this sudden large increase and large quantities were pressed on to the market after buyers had bought substantially at prices which, according to previous experience, were quite satisfactory to them, and depression in the price quotations was the natural consequence. In 1923, however, the market had adjusted itself and worked more normally, and it is to be noted from the diagram that from May 1923 consumers filled up their stocks at prices substantially below public quotations, averaging about 10s. on an average price

of about £8.12s.6d. This part of the diagram illustrates what is believed through various enquiries to hold fairly generally, namely, that " consumers " price is as a rule below " market " price. There is reason to think that this would hold more markedly in the case of commodities which, in addition to being articles of industrial consumption, are also fairly freely speculated in. It would be of great value if diagrams similar to the above could be compiled for articles of greater industrial importance. General principles and this one illustration are sufficient, however, to warrant scepticism regarding the existence of a close relationship between public price quotations and prices paid by consumers for any one article. The statistical mixing of price quotations is calculated to produce a result still further removed from a correct representation of the state of industry.

If an index number of prices is of doubtful use for the purpose of throwing light upon the state of industry in a single country the comparison of such indexes for different countries is of even less value as an indication of the relative movements of industry in the two countries. There are, in the first place, differences in the mathematical methods by which the indexes are compiled, but these are comparatively unimportant in comparison with the differences in the data used and the manner of handling these data. The reason for this arises through the different degrees of importance which are attached to particular articles and classes of articles in the indexes compiled in the various countries. For example, in the German official index number of prices in recent months leather and its raw materials have been more important than metals and petroleum put together, and have been 60 per cent. as important as textiles. In the Sauerbeck index number in England, however, textiles are four times as important as hides and leather, while in the British official index number there are thirty-one textile quotations used to four quotations for hides and leather. In the price index number compiled by the Bureau of Statistics in Australia textiles are twenty times as important as leather. If textiles rose by ten per cent. while hide and leather prices fell ten per cent., the remaining prices used in the Sauerbeck index number being unchanged, the index would go up by about three points but the German index would hardly be changed, while the Australian index would rise to a greater extent. In the case of the price index number compiled by the United States Bureau of Labour Statistics food represents only about twenty per cent. of the total. In the Board of Trade index in England it represents about thirty

per cent., and in the Sauerbeck index number about forty per cent.

The differences are of sufficient importance to warrant setting out in detail, and in the statement below the contributions of the various classes of commodities in a few index numbers are set out as a percentage of the total for the latest figures available :

PERCENTAGE COMPOSITION, BY GROUPS, OF VARIOUS INDEX NUMBERS

Index	Group	Per cent.
British Board of Trade	(1) Cereals	10.9
	(2) Meat and fish	11.2
	(3) Other foods	13.6
	(4) Iron and steel	10.8
	(5) Other metals and minerals	10.5
	(6) Cotton	17.5
	(7) Other textiles	14.0
	(8) Miscellaneous	11.5
Economist	(1) Cereals and meat	17.8
	(2) Other foods	23.6
	(3) Textiles	24.6
	(4) Minerals	18.4
	(5) Miscellaneous	15.6
Sauerbeck	(1) Vegetable food	14.8
	(2) Animal food	19.4
	(3) Sugar, coffee and tea	11.8
	(4) Minerals	19.1
	(5) Textiles	20.3
	(6) Sundries	14.6
German official	(1) Cereals and potatoes	9.0
	(2) Fats, sugar, meat and fish	12.1
	(3) Provisions and hops	18.2
	(4) Skins and leather	12.5
	(5) Textiles	21.6
	(6) Metals and petroleum	11.8
	(7) Coal and iron	14.9

The differences in the weights attached to the various groups of commodities can be noted from the fact that the group of textiles covers over 31 per cent. in the British Board of Trade index, 24.6 per cent. in the *Economist*, 20.3 per cent. in the Sauerbeck, and 21.6 per cent. in the German index.

It is clear from these percentages that a rise in price in cotton would have a much greater effect on the official index number in England than in Germany, and a mere comparison of the general indexes might lead to the inference (on the assumption that an

increase in the index represents an improvement in the state of industry) that the state of industry in the former country was improving while it was not similarly moving in the latter country. Between March 1922 and March 1923, for instance, the wholesale price index of the United States Bureau of Labour Statistics rose from 152 to 159, while the Board of Trade index in England was practically the same at the end as at the beginning of the period. We are not justified, however, from this mere statement in assuming that something was happening in the way of industrial activity or even of general price movements in America different from what was happening in England. It may have been due to movements in prices of certain commodities to which much greater weight was attached in the one index than in the other.

For the reasons which have been illustrated in this paper it is considered that the use of a price index number for any purpose other than the mere statistical one of measuring the average of variations in price quotations is likely to produce misleading results. A great deal of light may be lost in the process of striking an average. It may be the fact, as is assumed in the orthodox theory, that an increase in the price of a particular commodity, say cotton, is indicative of an increase in prosperity in the cotton manufacturing industry, and is likely to lead to more activity in employment; it is fairly certainly the case, on the other hand, that the orthodox theory is not applicable to the case of the leather industry and that an increase in hide prices is indicative of the opposite effect and tends to reduce employment in that industry. In a community concerned only with cotton and leather, therefore, increase in industrial activity would be indicated by increasing cotton prices but decreasing hide prices. A price index number combining the two movements would show no movement under those circumstances and the significance of the movements of the prices separately would be entirely lost. The explanation of the differences in the cases of the two commodities is probably connected with the fundamental differences between the factors associated with the production of the raw material concerned. An increased demand for cotton goods quickly reacts on the price of the raw material, and this, in a reasonable time, causes generally an increase in the supply of the raw material. This acts as a check on the rise in price and the increased demand can be dealt with without excessive increase in price. With leather, however, quite different factors operate. Hides are a by-product of meat, and however great the demand for leather and the increase in price of hides may

be only a comparatively small increase in supplies of hides will be forthcoming. A particular increase in demand for leather would cause a much bigger increase in price than a similar increase in demand for cotton goods. The increased demand for leather is accordingly quickly arrested (it is transferred to substitute articles), and as the process of tanning is a long one and the experience of the trade very extensive, the tanner frequently begins to reduce his production soon after the signs of rising prices have become manifest. The case of hides is perhaps the extreme example of a raw material being a by-product. Other raw materials — e.g. crossbred wool and tallow — are however similar, and it is probable that the experience of the woollen industry is somewhat similar to that of the leather industry, and opposite to that assumed generally by orthodox theory. During the period of increasing industrial prosperity in Great Britain covering the period from 1908 to 1913 the Sauerbeck index number of prices in general rose from 73 to 85 (16 per cent.). Hide prices, however, rose by 55 per cent., English wool prices by 47 per cent., but American cotton only by 22 per cent. The increase in the quantity of hides used is estimated at about 5 per cent., and this is a measure of the increase of employment in the period ; while the increase in the quantity of cotton used was more than 8 per cent.

In the light of the criticism made in this paper it may be suggested that before price index numbers can be reliably used for the purpose of shedding light on industrial circumstances, the whole foundation of the subject should be revised. If the object be to obtain an index of general industrial activity this should be built up from a system of indexes representing the state of activity in individual industries, and these indexes should be built up on material appropriate to each separate industry and combined by some approved statistical method. It may be that the experts in one particular industry would accept a rise in the prices ruling in that industry as a sign of activity, while those in another industry might accept the reverse criterion. These " indexes of prosperity " for individual industries could quite properly be combined into a " general index of industrial prosperity " and this is the index which should be used for the purpose of industrial discussions and not the ordinary index number of prices.

It must be confessed, however, that the prospects of getting such a system adopted in any country are rather remote. In a number of countries organisations for individual industries exist which could bring to bear the requisite expert knowledge on the

subject to produce the " indexes of prosperity " for those industries. It would be necessary, however, to have all important industries within such a scheme, and as the whole of the work, including the necessary co-ordination for the production of the " general index of industrial prosperity ", would be voluntary there would be difficulty in getting the necessary impetus to start the scheme and momentum to keep it going subsequently. It cannot be too strongly emphasised, however, that at the present stage the problem of index numbers designed for the purpose of throwing light on industrial conditions is one for the industrialist rather than the economist, and the onus of making the necessary advance lies, accordingly, on those organisations concerned with industry.