

Statistics of deliveries and orders in the engineering industries

The background to the new monthly enquiry

Summary

This article describes the enquiry into deliveries and orders in the engineering industry⁽¹⁾ which was in operation between 1958 and 1971 and gives the results of an investigation into its methods and some particular defects. Finally, it sets out the ways in which certain findings of that investigation have been implemented in the new monthly enquiry into sales and orders in the engineering industries.

Introduction

The issue of the *Board of Trade Journal* for 8 May 1959 contained an article introducing 'A new scheme of engineering statistics'. This new scheme formed part of the programme of improvement in the country's economic statistics which was outlined by the then Chancellor of the Exchequer, the Rt. Hon. Harold Macmillan, in the House of Commons on 1 August 1956. The scheme, known as the KS/Eng enquiry or as the comprehensive engineering enquiry, took over from a less uniform and complete arrangement in which the regular supply of statistics for the engineering industries had been based on a large number of separate forms, each for a separate category of products. Estimates of changes in the activity of the whole group of industries had been derived from those more limited enquiries in spite of the known inadequacies.

Now, as a part of the current development of industrial statistics (see the article by J. Stafford in *Statistical News*, 1.7) a further review has resulted in a second redesign of the enquiry surveying the economic activity of the engineering industries. The first period to be covered by this new enquiry was January 1972.

The comprehensive engineering enquiry (1958—1971)

The comprehensive engineering (KS/Eng) enquiry was introduced in 1958 by the Board of Trade. The full quarterly enquiry and monthly sample enquiry provided a means of obtaining comprehensive and timely indicators of changes in output and orders for the very important mechanical and electrical engineering sectors of industry (representing at present 16.8 per cent of the total weight in the current index of industrial production and 22.4 per cent of the total weight of all manufacturing industry). The general form of the enquiry was settled at that time as well as the methods of calculating the various index numbers and other statistical indicators and series which are produced from the basic data. Since then, there has been some further extension of the coverage in terms of both product and respondents and also some amendment to the enquiry form consequent upon the revision to the Standard Industrial Classification (SIC) in 1968, but the basic methods have not been altered.

⁽¹⁾ Orders VII to IX of the 1968 Standard Industrial Classification.

The data derived from the comprehensive engineering enquiry formed the basis for the following series:

- (a) *Index numbers of the volume of orders and deliveries.* These were produced for the total of the three SIC Orders VII (mechanical engineering), VIII (instrument engineering) and IX (electrical engineering) and for the three Orders separately. Nine time series were derived for each of the three SIC Orders and for the total, as follows:

Orders on hand	Total Home Export
Deliveries	Total Home Export
Net new orders	Total Home Export

- (b) *Input to the index of industrial production.* Monthly indices of volume of deliveries for each order were also calculated from the enquiry data. The Central Statistical Office who are responsible for the index of industrial production, obtained data for MLH 342 (Ordnance and Small Arms) separately and combined it with the contribution for Order VII from the enquiry. Indices were published for the separate SIC Orders.
- (c) *Provision of value figures.* In addition to providing index numbers as described, the enquiry also served to provide current value figures for groups of principal products of each of the industries, in the area covered. These were published quarterly, without seasonal adjustment, in the *Monthly Digest of Statistics*.

Methods used in calculating the index numbers

The enquiry attempted to cover all firms employing more than 25 people which are classified to the mechanical, instrument and electrical engineering industries. All of these firms were asked to send in returns at least once a quarter whilst a sample, containing most of the large firms, completed monthly forms.

The whole field was covered by two similar forms—one for mechanical and one for electrical and instrument engineering. The monthly and quarterly forms were virtually identical. Information was sought under a number of principal product group headings relating to the products of each of the minimum list headings (MLH) within the industry groups.

For each product heading, four figures were collected:

Deliveries, total and export
Orders on hand, total and export

It was thus possible to compile statistics of the total deliveries and orders on hand not only for the whole of mechanical, instrument and electrical engineering but of the principal products of each industry. The values of principal products of an MLH were used as proxy indicators of activity in that industry as a whole.

Total and export figures for both deliveries and orders on hand were obtained by direct aggregation from the returns; the components for 'home' were then derived as the differences between the appropriate total and export figures. Because respondents from the engineering industry, in general, find it easier to provide returns of orders on hand rather than of net new orders, the latter were not asked for explicitly. Net new orders (NNO), as published in index form, were derived from the delivery (DEL) and orders on hand (OOH) figures after deflation for price changes and seasonal adjustment had been carried out on both sets of figures, using the following definition:

$$NNO_{(t)} = DEL_{(t)} + [OOH_{(t)} - OOH_{(t-1)}]$$

It should be noted that the entity thus defined as 'net new orders' differs from the value derived by a direct measurement of new orders, firstly because the derived net new orders are automatically diminished by cancelled orders (which are reflected in the enquiry data for orders on hand) and partly because of any errors or omissions in the collected data for deliveries or orders on hand.

The various series listed earlier were derived from the enquiry data in differing ways. A form of chaining was used on the monthly calculations for the index of industrial production (i.e. those derived before reference to quarterly data) but all other series were derived by reference to the base year value. However, in all cases monthly series were corrected to correspond with the quarterly series as these became available. In the quarterly calculations for the index of industrial production estimated values at minimum list heading level were combined by net output weights to give series at SIC Order level. Indices other than those for the quarterly index of industrial production were compiled at SIC Order level: this was the equivalent of gross output weighting. In every case, the indices were expressed in volume (or quantum) terms by dividing the estimated current values (or corresponding value index) by a wholesale price index for the appropriate industry products. Whilst the components for the index of industrial production were passed to the Central Statistical Office without adjustment for seasonal factors, other indices were published in the seasonally adjusted form. Seasonal adjustment was done by multiplicative factors obtained from the US Bureau of the Census, Method II (X-11 variant), which is also the method employed by the CSO in seasonally adjusting the components and main totals of the index of industrial production.

The calculation of the monthly index involved a weighted linking process due to the fact that the enquiry data were based on a limited sample. The monthly sample was divided at SIC Order level into three strata; all large firms were included in the first stratum but only 1 in 5 of medium firms in the second, while 1 in 10 of small firms was sampled in the third. For the monthly

link each return was multiplied by the reciprocal of the sampling fraction and the link was therefore:

$$L_t = \frac{\sum_{J=1}^3 W_J \cdot T_{Jt}}{\sum_{J=1}^3 W_J \cdot T_{J(t-1)}}$$

where L = Link
T = total value of matched set
W_J = 10, 5, 1
t = current period
J = stratum

The link L_t defined above was then used to derive a total representing all firms for the current period. This was, essentially, on the basis that

$$Y_t = Y_{(t-1)} \times L_t$$

(Y_t and Y_{t-1} each being before price deflation and seasonal adjustment).

A working day correction factor was incorporated into the calculations for the index of industrial production and the quarterly calculations for the index of deliveries.

A further aspect of the problem lay (and indeed still lies) in the fact that, although firms were asked to reply promptly, the first provisional monthly index numbers were needed when sometimes only about half of the returns had been received. Provisional indices were calculated at approximately 5 weeks (first link) and more complete estimates at 9 weeks (second link) after the end of the period. Depending upon the stage in the quarterly cycle (since monthly indices were made final only when related to the final figures of the appropriate quarters as based on the full quarterly enquiry) it could be five months after the end of the period before monthly indices were regarded as 'final' and not amended further. Estimation for non-response was carried out by means of a simple ratio estimator. Information relating to the current period was linked to comparable information (i.e. in terms of matched pairs of respondents) for an earlier period so that a ratio or percentage change could be produced for each industry and each SIC Order. A set of returns for the current period from a reporting unit was used only if the same reporting unit also made a return in the immediately preceding period. The matched sets were aggregated to produce totals and from these the ratio or link L_t was obtained (see above).

Study of the performance of the enquiry

Reasons for dissatisfaction

Until the end of 1968 the index numbers appeared to be relatively stable. During 1969, however, they began to display an unusual volatility and proneness in the early estimates to appreciable revision. With hindsight it appeared that a good deal of this volatility arose from two operational changes introduced at the beginning of 1969—a revised enquiry form resulting from the 1968 revision to the Standard Industrial Classification, and the teething troubles associated with the transfer of the data, processing to a new computer system. Nevertheless, the behaviour of the index numbers suggested the need for a more fundamental examination of the system from the statistical point of view. The statistical examination was

conducted during the latter half of 1970 and early 1971 by the Department of Trade and Industry, with members of the Department of Economics and Statistics at Edinburgh University acting as consultants, and with the help of the CSO. The CSO has recently taken steps (use of a weighted average trend of past figures: see *Trade and Industry* 14 October 1971, page 95) to provide a smoother series and one less prone to major revisions.

The ensuing investigation devolved into finding the answers to the following five main problem areas which are important and at the same time susceptible to statistical analysis using the data available, and where any findings could be implemented in the new enquiry without too much difficulty.

- (a) *Response*. The characteristics of early responders—size, percentage change, variance—were investigated in order to try to improve early estimates.
- (b) *Stratification*. Two methods of stratification were considered—by size (in terms of turnover) and by industry.
- (c) *Estimators*. A number of ratio and regression estimators were compared.
- (d) *Size of sample*. The efficiency of the present sample was considered and the effects of ignoring the small firms assessed.
- (e) *Error*. An estimate of the degree of error present was made at various levels of response.

In order to investigate these problems the data for all firms throughout 1969 and part of 1970 was analysed. In addition a more concentrated analysis was performed on a few months of this period by running a simulation exercise.

Results of the investigation

It is only possible to include in this short article a selection of the operationally important inferences which were drawn from the material. These are given in the order of the headings listed above.

It was not found possible to determine the characteristics of early responders sufficiently firmly to justify their use in predicting the final response. There was some evidence of a tendency for the smaller firm to reply sooner than the larger one but this, if it existed, was not very pronounced. Moreover there was a high degree of variability between periods that made it more difficult to infer the value to be expected from the full sample.

Stratification by size was found to be a useful method of arranging the data, but stratification by industry in addition was found to result in little improvement over stratification by size alone. However, stratification by industry had the advantage of facilitating separate industry analyses and a particular point that became apparent was the tendency for any stratification by size to require revision fairly quickly.

A number of ratio and regression estimators were assessed and various lags and combinations of lags were looked at. No clear preference on statistical grounds emerged and it was concluded that a single lag ratio estimator, with its attendant advantage of simplicity, would continue to be the appropriate method although the more complicated estimators would possibly repay studying in the new enquiry.

It was found that omission of the smaller firms made only a marginal difference to the calculated link relatives.

When estimates of error were made, the situation at first link (the earliest estimate: see 'Methods used in calculating the index numbers') was understandably the worst. Although it was not found possible to derive confidence intervals in precise terms, it was judged empirically that estimates for the indices for single SIC Orders could well be as much as five percentage points out when the first link was calculated 5 weeks after the end of the reporting period. Furthermore, the volatility over time of the variance associated with the estimate of the link relative derived from the sample, suggested that there were additional uncertainties associated with using the conclusions outside the period from which the data used in the investigation had been drawn.

The new enquiry

The context

The development of a new monthly enquiry into the engineering industries has to be seen in the context of the new look being given to official industrial statistics as a whole. The former system of quinquennial censuses supplemented by an incomplete collection of short period enquiries is in the process of being replaced by a comprehensive range of related quarterly enquiries supplemented by annual and less frequent enquiries. The quarterly sales enquiries, the pivot of the new system, call for each reporting unit to return all its sales and receipts on the one form. Although the questionnaire is detailed in product terms and final analysis will embody full carry-in⁽²⁾ and carry-out,⁽³⁾ the enquiries are based on 'census industries', (i.e. all respondents are classified to a particular census industry: a census industry being roughly congruent with a minimum list heading in the Standard Industrial Classification, 1968).

In particular therefore a definite relationship has had to be specified with the quarterly sales enquiries into engineering, which take the place of the quarterly element of the comprehensive engineering enquiry. The purpose and content of the quarterly sales enquiries, by which all industries will eventually be covered, and the procedures for carrying them out, have now been settled in essentials for some time (see R. W. Green, *Statistical News*, 8.7). Although the quarterly sales enquiries for the engineering industries have either only just started or are shortly about to start, there is a considerable back-log of experience in other industries (see A. A. Sorrell, *Statistical News*, 6.4 and 7.22).

Since the form and scope of the new quarterly sales enquiries had been settled, any adjustments needed to ensure correspondence between the quarterly and monthly enquiries have tended to fall on the monthly rather than the quarterly side. The quarterly enquiries collect product details but they are industry-based, in that each enquiry covers the total sales of establishments

(2) 'Carry-in' is defined as the value of sales of the principal products of the particular census industry made by firms classified to other census industries.

(3) 'Carry-out' is defined as the value of sales of the principal products of other census industries made by firms classified to the particular census industry.

classified to an industry. This has influenced the decision that the new monthly enquiry should be industry-based and not commodity-group-based as the previous enquiry (1958—1971) was. The fact that the same population of firms is being surveyed for both the quarterly and the monthly enquiries raises the question of consistency of reporting by the same respondent to the two enquiries. To make the situation easier for the respondent and to obtain consistency between the monthly and quarterly figures, it was decided that the figure asked for on the monthly enquiry form should correspond to the total on the quarterly form. Therefore there is a change from deliveries to sales between the old and the new monthly enquiries. The notes on the new questionnaire define sales as deliveries on sale and specifically include, in addition, sales of waste products, residues, etc.; receipts from work done and services rendered to other organisations; and sales of merchant goods. These additional receipts were excluded from the product deliveries totals in the previous enquiry. Canteen takings are excluded, as they are from the quarterly enquiries.

The new questionnaire is therefore much simpler than the previous one. Leaving aside the identifying questions, four cells only (sales, total and export; orders on hand, total and export) replace the page of commodity-group rows on the old form. Further, one form suffices for the three SIC Orders instead of two types as before, as no product detail is to be collected.

Another general factor affecting the overall design of the new enquiry follows from the desirability of fitting in the new monthly enquiry as far as possible with the general reorganisation of official industrial statistics referred to above. The Business Statistics Office is the collecting agency for this system. The resulting call for standardised practice has influenced the design of the new enquiry in at least three areas.

First, the use of a common register has imposed the need to take particular care in negotiating the catchment area for the individual respondent. For example, information on orders on hand is not always readily available at the same level in the hierarchy of the enterprise as sales information. Another way in which a necessity for a compromise solution arises in this same area is through the decision to include merchant goods in the concept of 'sales' and the consequence of this for firms with several establishments. There is a practice in certain of such firms of controlling total sales operations from one of several manufacturing units. This means that goods produced at one address may well be entered as a 'purchase' at the sales office in another address of the same enterprise, and then be 'sold' again from there. One way to avoid including this additional quantum of merchant goods would be to cover all the addresses of the enterprise on the one responding form. However, other considerations such as a desire to differentiate between returns from different economic regions can come into conflict with this solution. Hence, a specific compromise solution has to be found for each individual case.

Secondly, standardisation of computing practice can also lead to compromise between the desired optima of individual enquiries. The imputation techniques for deriving value figures may not be precisely the ones which would be chosen for deriving series of indices.

Thirdly, it is desirable that the wording and therefore the notes, where possible, should be standardised on questionnaires issued by the same collecting agency. This can feed back into the choice of entity about which the questions are being asked.

The enquiry

With the results of the quantitative study and the factors outlined above in mind, two further major decisions were made. The first of these was that the enquiry should be made statutory. It was felt that by this means, the chance of getting usable information as early as possible would be maximised, an important factor in this type of enquiry. Secondly, it was decided to change the sample type to the form known as a cut-off sample. Using the detailed results of the study referred to above, the levels of cut-off for SIC Orders VII and VIII were set at respondents employing one hundred and that for SIC Order IX at respondents employing two hundred people. By including everyone over these levels, it is expected to improve appreciably the ability of the sample to represent the statistical population and, at the same time, by omitting those under these levels it has allowed some reduction of the form-filling burden on industry. The risk of appreciable bias often associated with the use of a cut-off sample is countered by the proposal to use the results of the extensive quarterly sales enquiries as a continuing definitive series.

One difficulty in this respect is that the quarterly sales enquiries are not asking respondents about their orders or in general about their exports. It will not, therefore, be possible to use the quarterly enquiries as a reference for these facets of the new monthly enquiry. However, it is hoped to overcome this problem with periodical enquiries on a sampling basis.

As stated earlier, a single lag ratio estimator is being used. A ratio derived from matched pairs is used to impute values for non-responders. The imputed values are incorporated in the monthly totals, from which indices are calculated.

One of the improvements introduced on a regular basis is the identification of and the allowance for atypical respondents in a particular pair of periods. Where imputation procedures are used, misleading results may be obtained from using the early values returned without discrimination; if the early returns are unrepresentative the totals imputed from them can be seriously wrong.

The derivation of indices

As before, the new monthly enquiry will produce nine series, the total, home and export series in respect of sales, orders on hand and net new orders for each SIC Order. The identity used in the new enquiry to obtain net new orders is the same as the one quoted above as used in the earlier enquiry. However, it is applied more logically at the raw data stage and not, as previously, after adjustments for price changes and seasonal factors.

Another new feature in the derivation of the monthly indices from the new enquiry is that the method of aggregating to SIC Order level is changed. For the index of industrial production, apart from the difference arising from moving from a product orientated enquiry

to an industry based enquiry, the change is effectively one of applying to the monthly index the procedures which were used for the quarterly index in the old enquiry: that is to say the indices for the SIC Orders are built up from individual indices for the appropriate census industries using 1963 net output weighting. In the case of the derivation of the indices for sales and orders from the new enquiry the values for the various census industries are weighted in the proportions of their gross output in 1963. The latter represents a more substantial change from the procedures outlined in 'Methods used in calculating the index numbers': the practice in the former enquiry was to aggregate the various value totals at SIC Order level before dividing through by the base value; this approximated to gross output weighting at current values.

The indices at the census industry level are derived from imputed totals for the period concerned related to given values for the base period. The index calculation programme on the computer also applies price deflation to the value ratios to give volume indices, and provides adjustment for seasonality, using factors derived from application of the X-11 variant of the Census Method II. A final programme produces trend estimates of these volume indices which are then ready for publication in the new series of Business Monitors which has been created for this purpose. The seasonally adjusted monthly series of deliveries and net new orders show considerable volatility, and it is thought that smoothed indicators of change in the industry in the short period, as given by trend values of the indices, will provide a useful ad-

ditional series which will also be published in the Business Monitor.

The relationship of the new monthly enquiry to the quarterly sales enquiries will indirectly allow a more refined procedure of deflation. The commodity detail of the quarterly enquiry enables wholesale price index numbers to be applied to sales of product groups within individual census industries, (i.e. at a more detailed level than can be carried out on the monthly enquiry). The individual series at constant prices so obtained when aggregated will enable an essentially base-weighted volume index to be derived for each industry. This finer level of working of the quarterly data achieves much the same effect as the application of a currently weighted wholesale price deflator to the current values of sales of each industry. This implied price deflator provides certain essential information also for the final conversion to constant prices of the monthly enquiry results, (which will first have been deflated by a proxy wholesale price index at census industry level).

Conclusion

The new monthly enquiry into sales and orders in the engineering industries was introduced in January. A considerable amount of work has gone into selecting the optimum solution to the various problems identified. The changes made, including the selection of a larger, better designed sample; making the enquiry statutory; and the use of a simpler questionnaire; should lead both to earlier response and to improvement in reliability.

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