

## CHAPTER 11

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### THE BALANCING OF QUARTERLY ACCOUNTS

*This chapter recommends that there should be a single definitive measure of GDP, that full balancing should be undertaken to ensure that no statistical discrepancies are left in the data (either in raw or seasonally adjusted data), and that all variables should be subject to adjustment. It discusses the general statistical issues arising from the balancing process including the use of supply/use or input/output tables, adjustments to other variables related to national accounts, and the effects on consistency with the annual figures and on the process of revision.*

*The chapter introduces multivariate mathematical and statistical techniques for adjustment and disaggregation. It also recommends that the organisational arrangements for balancing should include a work programme for introducing balancing procedures, a clear timetable allowing sufficient time to undertake thorough balancing, and information for the users of the statistics on the balancing process. The chapter is supplemented by two annexes. The first annex is a formal presentation of balancing by mathematical and statistical methods. The second annex describes a framework for the quarterly balancing process.*

## The balancing of quarterly accounts

### *Introduction*

- 11.01. The balancing process is an integral and vital part of the methodology used for compiling the national accounts statistics. In its operation, the process attempts to make optimum use of the diverse range of information which is collected and used for deriving the national accounts. In broad terms, balancing seeks to fit the statistical data from the production, expenditure and income measures of GDP, and possibly financial accounts, into one or other of the theoretical frameworks (supply/use, input/output, sectors) which underpin the accounts. The end-product of the balancing process should be a fully articulated and balanced set of accounts, with a single, definitive estimate of GDP, and component series across the three measures which are fully consistent with this estimate. This chapter will look at some general principles and procedures of balancing, and also consider issues of particular relevance to balancing quarterly data. Some operational and related issues are also raised.
- 11.02. The way in which estimates of GDP and other national accounts components are made in practice will depend much on the range and quality of the information available. For example, very few countries have the full range of largely independent production, expenditure and income data, even annually. In the main, it would appear that annual GDP figures are compiled on the basis of production estimates, such information being fairly readily available from statistical surveys or administrative sources. Many countries also have annual expenditure data which, in addition to being of interest in their own right, will also be used in the determination of GDP. However, income data, perhaps mostly obtained from the administration of the tax system, are at present compiled in comparatively few countries. The range of financial information available also varies widely, but these data are usually collected only once a reasonable statistical system has been established for measuring the 'real' economy.
- 11.03. Generally speaking, quarterly information is less detailed and less accurate than annual data. This reflects, in part, a need to have some limit on the statistical burden on contributors, which should not to be overcharged with statistical obligations to compile basic statistics to be used in quarterly accounts, and also the less detailed requirements of the quarterly statistical system, in terms, for example, of level of breakdown. Having said that, some countries appear to be placing increasing emphasis, at least for some variables, on developing the quarterly information as the main data source for the accounts. Provided information is sufficiently reliable, this approach clearly avoids the problem of revisions.

- 11.04. Balancing can be undertaken in a number of ways. The most widely-used approach is based on the *industry/product framework of input-output both supply and use tables and the symmetric tables*. This methodology provides the means of establishing a definitive GDP figure and also consistent estimates of the component series, based on data collected from production, expenditure and income sources.

The balancing process may also be based on the framework of the *institutional sector accounts*, which bring together data contributing to the three measures of GDP with associated information on financial transactions.

It is also worth mentioning that partial balancing for particular commodities may be undertaken through the use of the *commodity flow approach*. However, where this approach is used to estimate demand from supply consistency between production and expenditure is achieved but the procedure is not strictly balancing.

Given the likely restricted availability of financial accounts data, particularly quarterly data, the main emphasis in this chapter will be on the use, for balancing, of the supply/use or input-output tables.

- 11.05. It should be stressed that it is by no means a prerequisite for balancing to have a comprehensive range of largely independently-estimated data. Indeed, it could be argued that the less the data available, the greater the need to try to include them into the structure of the accounts, if the data are reliable. Where data are scarce, the very fact that they should fit into the framework is a crucial piece of additional information which should not be ignored. It is very desirable, therefore, that some attempt is made to incorporate the information available within one of the particular frameworks of the accounts mentioned above. Such an approach will almost certainly improve the quality of the estimates, for both component series and the aggregates. Balancing should be undertaken for both current and constant price information, in order to provide an integrated and consistent set of accounts, and which, in doing so, also makes optimum use of the price data.

- 11.06. The issues of balancing which are relevant for annual data will also largely apply to the quarterly process. However, there are a number of other factors which affect what might be done quarterly.

One of the main points, as mentioned earlier, is that the range and quality of quarterly information which is available will generally be much less than for the annual estimates. As suggested above, arguably, this increases the need for bringing together all the available data within a known framework. At the same time, it will inevitably mean some simplification for the quarterly approach, such as a much less detailed input-output or sector accounts framework, compared with what is done annually, and quarterly balancing will, most generally, be undertaken only after annual balancing has been established.

A second important difference is that quarterly balancing can be undertaken for both unadjusted and seasonally adjusted data. The need to deal with these two sets of data, as well as current and constant price figures, and the greater statistical variability of the quarterly data, will all add to the time and operational complexity of the whole balancing

process. However, as mentioned above, there will be some simplification in the detail of the process compared with the annual approach.

A third, related point which needs to be borne in mind is that timeliness is perhaps a more important part of the quarterly statistical round than it is for the annual figures.

- 11.07. Finally, it is useful to draw a distinction between two roles for the balancing process. The first role relates to balancing data for the current or latest quarter. The second role involves starting with established sets of balanced data for the four quarters of the year, and then making the quarterly figures consistent with firmer annual figures which become available. The introduction of these alignment adjustments is likely to require a re-balancing of the quarterly accounts. The bulk of the discussion in this chapter is really about balancing for the latest quarter, rather than about balancing subject to the constraints of annual figures. However, annual adjustment apart, the methodology corresponding to the two roles is the same. The issue of alignment is discussed in Chapter 10 on time consistency. The extension to retrospective balancing is considered in the present chapter in §11. 51-52.

### ***Key principles of balancing***

- 11.08. Mention was made earlier of certain principles which should underlie the balancing process to be used in the national accounts. These should apply equally to annual and quarterly data. Three important issues can be stated:
- First, as mentioned above, even though GDP may be estimated independently from production, expenditure and income sources, as available, there should be a single, definitive measure of economic activity.
  - Secondly, once such an estimate has been established, the component information should be adjusted so that each of the separate production, expenditure and income measures is consistent with the overall GDP estimate. Put another way, the accounts should be fully balanced, with no statistical discrepancies or residual errors.
  - The third principle is that, in order to achieve balance, all component series, and not just selected variables, should be subject to possible adjustment.

These principles are considered briefly in the paragraphs which follow.

- 11.09. On the first principle, it would clearly be very confusing to users and others to have more than one figure for GDP in the public domain. It is fair to say that there is probably little dispute with the idea of a single estimate of GDP. In practice, the definitive figure should be based on information from the production, expenditure and income measures, as available.

On the second principle, however, the extent of the adjustment procedure varies. For some countries, although a single GDP is established and figures for certain variables are adjusted, there is caution about eliminating completely the discrepancies in the separate measures, and residual errors or statistical discrepancies remain in the various estimates.

This practice is normally justified on grounds of not wishing to make too large changes to the basic data, and of not knowing where precisely any such adjustments might be made.

- 11.10. It is also often argued that such adjustments may be viewed as largely arbitrary and lacking transparency for users outside government. Further, large adjustments to figures may often be thought of as distorting the basic information which is actually collected and compiled. All this could have a major adverse effect on the public confidence which might be placed in the figures.

Finally, and of obvious importance, there are the practical aspects of balancing, whereby operational and timing difficulties may seem to preclude carrying out anything other than a simple adjustment procedure.

- 11.11. On the other hand, accounts which contain residuals and are not balanced and do not fit into the measurement framework might be seen as 'unfinished', with the discrepancies largely reflecting the general quality of the underlying data. It is hard to accept that such accounts can be seen as providing a consistent and comprehensive picture of what is happening in the economy. Thus, the basic statistics are not being used in the optimum way and the best service is not being provided to users, who expect the national accounts experts to derive estimates which accord with the framework of the accounts.

It should also be observed that the basic statistical information which is included in the balancing process has already undergone a number of not always firmly-based adjustments. For example, where administrative sources of data are used, it may be necessary to modify figures so that the definitions accord with those required for the national accounts. Within surveys, there is the need for imputation for non-response or the effect of statistical grossing. The further adjustments made within the balancing process may therefore be seen as the final stage in a continuum of statistical estimation, and it is logical for this to be carried through in its entirety to achieve full balance.

Not to balance fully therefore involves an arbitrary decision on where to draw the line.

- 11.12. It should be said that full balancing is certainly not a subterfuge for manipulating data in support of a particular viewpoint. There is clearly more opportunity to manipulate the interpretation of the data when different GDP measures are available (although the existence of more than one measure could equally be seen as a contribution to transparency in the compilation process). Suspicions which users may have on this score should be allayed by careful presentation of results. Moreover, any concerns which exist on the part of the collectors and compilers of the statistics should be dealt with by appropriate education. Some aspects of the issues of presentation and education are discussed at the end of this chapter. However, the main argument to be advanced is simply that full balancing will provide the best set of national accounts data, making best use of all the information available.

Where operational problems arise, compilers should attempt to overcome them as best as possible. Amongst other things, this will include ensuring that sufficient time is available for the vital process of balancing. The need for balancing should therefore be a key feature in

the determination of the overall timetable for the production of the estimates, and not fitted in as best as can. Again, some issues are raised later (see § 11.70-11.71).

- 11.13. On the third principle concerning which variables are adjusted in the balancing process, again country practice varies. Where annual input-output tables are compiled, some countries tend towards unrestricted adjustment. In others, adjustment may be limited to a few of the less reliable variables, for example changes in inventories within the expenditure measure, and operating surplus within the income estimate. Occasionally, in respect of these two components, the variables may not even be measured, estimation being made simply as a residual from total GDP. The arguments put forward for restricting the adjustments to a few variables only are very much the same as those mentioned above in relation to the extent of the balancing process. In particular, there is the uncertainty about the magnitude of any adjustments, and also, with more variables being adjusted, the greater the complexity of, and the time needed for, the whole balancing process.

A further operational problem may arise in respect of information which is compiled and published outside the main national accounts production round. A particular example concerns the existence of monthly data of a quarterly series which may well be published before the overall balancing process can be undertaken. As such, these variables may need to be regarded as definitive and not adjusted in the balancing process. This issue is considered, further, later (see § 11.72-11.73).

- 11.14. Despite the various statistical and operational problems raised above, it is not considered adequate to restrict adjustments to a few series only. Such an approach will not provide the best estimates of aggregate and component series for the year or the quarter. Further, it will also mean that the time series of the one or two variables which are adjusted will not be very meaningful, since all the 'errors' in the variables not being modified will be incorporated, implicitly, in the estimates of those figures which are adjusted. It is recommended, therefore, that all variables should be considered for possible adjustment in the balancing exercise. It may be decided, for good reasons, that some variables are not adjusted, but all should be considered. The practical problems of following this approach are recognised and are not underestimated, but again attempts should be made to overcome them, for example by allowing more time for the balancing process.
- 11.15. There is one other point, relevant to both the consistency issue and the range of the adjustment process, which might be made. Given the complexity of data collection and estimation in the national accounts, whatever resources are used, there will always be inconsistency in the various measures. Thus, most generally, the basic figures will be unacceptable and there will be a need for some form of adjustment to them. If the principle of adjustment is accepted, then the issue would appear largely to be one of the extent to which it is carried out. Partial balancing leads to some improvement in the overall quality of the estimates. However, as argued above, estimates which are not fully balanced do not make best use of the available information and do not therefore provide the best representation of what is happening in the economy.
- 11.16. It will be useful to summarise the outcome of the consideration of the three main principles. It is recommended that, despite the practical and other problems mentioned earlier, the arguments are strongly in favour of a single figure for GDP, and for achieving complete

consistency in the published accounts, with no statistical discrepancies, and with all variables subject to possible adjustment. Only this approach can provide the most meaningful set of economic data. The onus is on the compiling statisticians to use their expertise to see that this is done. A number of problems, both statistical and operational, will need to be overcome. Other matters to be addressed will include informing users about the balancing process and, most crucially, maintaining confidence in the estimates. Some of these problems are considered further below (see § 11.75-11.79).

### ***Other main features of balancing***

- 11.17. Before looking at the specific issues for quarterly balancing, it is necessary to consider a number of other features of the balancing process. These are presented largely as recommendations as to how balancing should, in principle, be pursued. However, as will be evident in what follows, the extent to which they can be incorporated within balancing practices in individual countries will depend very much on the availability of statistical and other information.
- 11.18. First, the balancing process for both total GDP and the component series should be based on the accuracy of the data included in the (quarterly) accounts. To consider a simple example, if it were thought that GDP estimated from the production side was twice as accurate as the expenditure estimate then, other things being equal, the weights of the two estimates in total GDP might be broadly in the ratio of 2:1. In practice, as will be discussed later, the estimation of GDP is not as simple as this, since balancing will need to be considered in the detailed framework of the accounts being used. As a result, the final figure for GDP may not be the same as this estimate, although the difference should only be small. A broadly similar accuracy-based approach can be adopted for all variables to be adjusted in the accounts. Thus, if, for example, household consumption was estimated less reliably than gross fixed capital formation, then it would carry a larger relative adjustment.
- 11.19. It will be useful to consider further this key aspect of the balancing process. It is well recognised that the proper derivation of accuracy measures of the national accounts data is an extremely difficult process, so complex that few countries have even approximate estimates. There are likely to be very few variables in the accounts where the only source of error is the conventional standard error deriving from statistical sampling. Indeed, for most variables, non-sampling errors, which could well lead to bias in the estimates, are likely to be more important than sampling errors.
- 11.20. Nonetheless, it is important to have some, albeit approximate, indication of the accuracy of the data going into the accounts. This is good statistical practice and serves purposes other than for the balancing process. Two other important uses, for example, are as a basis for deciding on sample sizes for the statistical inquiries used to collect data, and secondly as an aid to interpretation of the published statistics. These uses require some absolute measure of accuracy. Ideally, absolute estimates are also required for the balancing process, if only to ensure that adjustments do not fall below a certain level of accuracy.

As a second best solution, however, balancing can utilise a relative assessment of accuracy, for example, that household consumption is, say, half as accurate as gross fixed capital formation, without needing to know the specific accuracy of each variable. In the absence of any firm quantitative information, which will represent the usual position in most countries, estimates of accuracy should be pursued through discussion by compilers, who should make their best, judgmental assessment. By this means, it should be possible to form some broad consensus view on the relative accuracy for all parts of the account. Having this material as a basis for balancing is certainly better than having no information at all. The accuracy of data sources should be regularly assessed because of the potential for changes in the underlying generating processes, which can rapidly lead to a change in reliability.

- 11.21. It is worth making the point that revisions are often seen as a measure of accuracy in the national accounts. This is true to a certain extent but it is essentially in the context of how far the initial information represents a reliable estimate of the final figure. However, such measures do not reflect statistical accuracy, and the absence of revision to quarterly data, say because annual figures are just not available, is clearly no indication of the basic quality of the data. Perhaps the main role of revisions is in seeing whether initial estimates might be biased and, if so, making some adjustment to try to anticipate them. The issue of revisions is discussed in Part VI of this Handbook.
- 11.22. It should be noted that the issue of the accuracy of the data is also relevant to another aspect of the balancing process. As will be explained later, part of balancing involves making use of information based on the structure of economic activity provided by the latest annual input-output tables, for example what proportion of output might go to household consumption. It becomes necessary, then, to make an assessment of the likely accuracy of such 'structural' estimates against that of the directly-measured data for the current quarter.
- 11.23. A further important feature about balancing is that, as well as achieving balance in the levels of the variables for a particular quarter or year, it is also vital to consider the related growth rates of the variables. In other words, it would not be acceptable to balance data for, say, two successive quarters if the results showed estimates of growth between the two periods which differed greatly from the original figures or was otherwise implausible. Thus, accuracy estimates are also required for growth rates, and, again, adjusted data should not generally fall outside the specified accuracy range. The estimate of accuracy in changes can be derived in two ways. The first way is by statistical formulae based on estimates for the levels and the likely statistical correlation between levels data. The second way of doing this is a judgmental one similar to that for the levels, noting that some statistical relationship should exist between errors in levels and changes. Similarly, for a longer period of interest, it is crucial that the adjusted components are plausible as time series. Data in this form are important in their own right for economic analyses. In practice, the need to consider balancing as a three-dimensional, rather than a two-dimensional, process clearly adds to the complexity of the whole exercise.
- 11.24. Another point to be borne in mind is that the data used in the balancing process should, as far as possible, be free of measurement bias. Where such biases are thought to exist for example as a result of a less than complete coverage of statistical registers, or reflecting inadequate definitions of variables the basic figures should be adjusted before being

incorporated in the balancing process. This issue is discussed further in relation to quarterly balancing in § 11.35.

- 11.25. The final feature to be identified is that, where possible, balancing should be undertaken, simultaneously, for both current and constant price data. In doing so, the methodology should incorporate the possibility of some adjustment to the component price information. In other words, the implied price series, derived from the ratio of the adjusted current to constant price data, are allowed to vary within reason from the original figures. In this way, not only are the current and constant price information made to fit into the framework of the accounts, but proper use is made of the available price data. Again, this is considered in more detail below, in relation to the quarterly balancing process, where there is the added complication of the existence of non-seasonally adjusted and seasonally adjusted data.
- 11.26. The principles discussed above largely apply to balancing of both annual and quarterly data. The chapter now goes on to suggest particular issues of, and procedures which might be followed for, quarterly balancing.

### ***Issues and procedures for quarterly balancing***

- 11.27. The main issue to be addressed arises from the fact that quarterly balancing can be undertaken for both non-seasonally adjusted and seasonally adjusted data. While the former provides the basis of the figures for compilation, the seasonally adjusted data are the much preferred form for interpretation and analysis. Thus, seasonally adjusted data should certainly be balanced. Further, it is also regarded as essential, in principle, to balance the non-seasonally adjusted estimates, thus providing a fully integrated and consistent set of data over the whole accounts. Indeed, for some countries the focus is more on balancing the non-seasonally adjusted data, largely because it represents the basic data, and is not affected by seasonal adjustment. However, balancing non-seasonally adjusted data raises a number of practical difficulties which are addressed below.

#### *Meaningfulness of the set of quarterly figures to be balanced*

- 11.28. The first issue is the need to have a meaningful set of quarterly figures which are to be balanced. For some variables, the figures appearing in the accounts will largely reflect administrative and other arrangements which exist for making payments. Three examples are interest payments, taxes on operating surplus, and recurrent taxes on land, buildings and other structures. Similar problems may arise where information is recorded on a cash, rather than an accrual basis. The question, given all this, is what constitutes a meaningful quarterly series.
- 11.29. The question has been considered in Chapter 3 on the accounting rules. In brief, for the seasonally adjusted series, for most variables it should be possible to establish an acceptable profile through the seasonal adjustment process. The problem of the meaningfulness of the quarterly figures relates, mainly, to the non-seasonally adjusted series.

In principle, with the exception of dividend payments and compensation of employees, all series, in both non-seasonally adjusted and seasonally adjusted form, should, as far as possible, appear on an accrual basis. Two possible solutions might be considered:

- in some cases, it will be possible to relate the variable of interest to an 'explanatory' variable. One example here would be to determine the quarterly non-seasonally adjusted profile for taxes on operating surplus by using the corresponding series of the operating surplus itself;
- where the first method is not possible, the quarterly non-seasonally adjusted series can be determined by some form of interpolation.

11.30. Partly reflecting the above, but also for other reasons, the non-seasonally adjusted quarterly figures will usually be somewhat more variable than their seasonally adjusted counterparts. Further, differences in the timing of the recording of the same transaction, and other deficiencies in quarterly recording, as discussed in Chapter 4, will be much more pronounced for unadjusted data than for the seasonally adjusted estimates, where seasonal adjustment will reduce the impact of regular timing differences.

The greater inconsistencies in the unadjusted, rather than the seasonally adjusted, data resulting from these two factors will be evident both within and between the production, expenditure and income measures. The timing issue and the other problems mentioned above are likely to mean that the non-seasonally adjusted quarterly series for GDP, based on the separate production, expenditure and income data, are likely to be significantly different. It is, however, necessary to determine the definitive non-seasonally adjusted quarterly GDP figure to which data are balanced.

11.31. A further potential problem with balancing quarterly non-seasonally adjusted data, which was touched on above, relates to the way in which information about the structure of economic activity of the previous year is used as a basis for making estimates for the current quarter. Reflecting seasonality, and other matters mentioned above, the assumptions needed for example, the allocation of an industry's output to household consumption are likely to be rather more tenable for the smoother, 'average' seasonally adjusted quarterly estimates than for the erratic non-seasonally adjusted data. Thus much caution will be needed when using these data in the balancing process.

11.32. This particular problem will be most relevant in the first year in which quarterly balancing is undertaken. After this, it should be possible to establish firmer quarterly supply and use tables which can provide the framework for the 'structural' estimates which enter the balancing process. In other words, the estimates of non-seasonally adjusted data for a particular quarter made within the balancing process can, where appropriate, be based on the supply/use framework of the same quarter of a year earlier.

11.33. Another statistical feature of quarterly balancing relates to the need to achieve balance for both the seasonally adjusted and unadjusted data. If these data are balanced independently, it will be necessary to ensure that the (implied) seasonal factors, following balancing, do not depart too much from the original factors derived from the seasonal adjustment process for the individual series. This requirement may be regarded as analogous to that obtaining for

current and constant price figures and prices. If balancing is undertaken, first, for non-seasonally adjusted data, the modified figures can then be seasonally adjusted, and the above requirement is no longer relevant.

- 11.34. It is clear from what has been said above that quarterly balancing of non-seasonally adjusted data is, potentially, a much more difficult process than balancing seasonally adjusted data, and special care will need to be taken with this part of the exercise. Nonetheless, as mentioned before, some countries place more emphasis on the balancing of non-seasonally adjusted, rather than seasonally adjusted data. One reason for preferring balancing unadjusted figures is that these represent actual data, and seasonal adjustment bring a degree of subjectiveness to the estimates.

The issue of the sequence of adjustments is considered further in § 11.41- 11.43.

- 11.35. One final issue needs to be raised. As mentioned in § 11.24, the data going into the balancing process should, as far as possible, be free from measurement bias. Unless this is achieved, the definitive estimate of GDP will not be a central estimate, while the balancing of, and estimation for, the component series will be less than optimal. For the component series, although balancing may be seen as a way of making some adjustment for bias, it is far preferable that the process should seek to allow only for statistical error.

- 11.36. In addition to these general points which have been made about bias, there is a specific matter relevant to the quarterly estimates. These estimates, as well as providing a short-period profile of economic activity, also serve as early estimates of the annual data. Thus, any bias evident in the quarterly figures will affect the initial estimates of the annual data. Where bias is thought to exist in the quarterly figures, adjustment factors should be applied to the quarterly data for the current year. These adjustments can be based on the long-run relationship between the annual and quarterly estimates, and on any other relevant information. In practice, the incorporation of such adjustments may also be seen as part of the procedure for aligning the quarterly and annual figures, with the former including any alignment factors which need to be projected into the future. The alignment procedure is discussed in Chapter 10, and the role of alignment in the balancing process is considered in § 11.51-11.52.

- 11.37. An important feature in the determination of bias is the evaluation of the pattern of revisions made to series arising from later data. The approach to monitoring and using revisions within the accounts and the policy for incorporating them in the published estimates are considered in Chapter 14. One particular feature is that balancing may lead to a revision to a particular component even though no new information has become available for that component. Some key points arising from quarterly balancing are mentioned briefly at the end of that chapter.

## ***The quarterly balancing process***

- 11.38. This section looks at how the key statistical and operational aspects, mentioned above, might impact, in practice, on the quarterly balancing process, including suggestions for the framework which might be used and how balancing might be undertaken. The discussion will be presented essentially in terms of balancing for the current period. Retrospective balancing is considered in § 11.51-11.52.
- 11.39. As mentioned in § 11.04, the most appropriate framework for the balancing process is provided by the structure of the input-output tables. These comprise either the separate supply and use tables, or the full symmetric product by product or industry by industry matrices. The symmetric matrices are generated from the supply and use tables, incorporating further assumptions about the structure of industries' consumption and production of goods and services. In practice, partly for this reason, it is suggested that quarterly balancing is undertaken through the supply and use matrices, rather than the symmetric input-output matrix. For the annual accounts, fairly detailed information on industries and products can be used in assembling the tables. However, reflecting a more restricted range of information, the framework to be used for quarterly balancing will need to be much more aggregated. The precise format will depend on the range of data available, and in the light of individual countries' needs, but the aim should be to use a matrix containing something of the order of 10-20 industries/products (a more disaggregated supply-use table is needed for constant prices than for current prices). The classification could be based on the single letter level of NACE Rev.1 (as with Classification A17 in Annex IV of ESA 1995), perhaps with some breakdown for manufacturing, which appears there as one industry, and also some distinction for capital goods (as in the Council Recommendation on Aggregations for Economic Analysis, No.96/162/EC of 8 February 1996). A balance will need to be struck between the greater homogeneity of a more detailed disaggregation and the resulting demands on data and the time needed for undertaking the work.
- 11.40. Annex B to this chapter provides an illustration of the kind of supply and use framework which might be used for quarterly balancing, but without proposing a specific industry classification, and explains how the component variables might be estimated. It is important to ensure that the various estimates going into the supply and use tables are properly and consistently valued.

The 'structural' information presented in Annex B may be regarded as applying to both current and constant price data, and also non-seasonally adjusted or seasonally adjusted figures. However, as mentioned earlier, care needs to be taken in using the annual structure of the input-output tables for balancing non-seasonally adjusted quarterly data. The format adopted for balancing can be readily modified to meet any specific individual countries' requirements, in the light of needs for statistics and data availability.

### *Steps of the balancing process*

- 11.41. The first step in the quarterly balancing process should be to establish some indication of the likely level and growth of total GDP.

The separate bias-free information from production, expenditure and possibly income sources, as available, should be 'weighted' together to form a provisional, first estimate of definitive GDP. The weights for this purpose should reflect the compilers' judgement on the relative accuracy of the various measures. This can be undertaken for both current and constant prices, as required, and in relation to both levels and growth rates. The plausibility and consistency of the derived figures should be ensured as far as possible, perhaps also in comparison with qualitative indicators.

At this stage, the GDP estimate is to be regarded as a 'target' in the balancing process rather than a definitive figure. However, in the absence of any new data, the final estimates for total GDP made after the balancing process should not be too different from this provisional estimate.

- 11.42. A particular feature of quarterly balancing is the requirement to balance data in non-seasonally adjusted and seasonally adjusted form, as well as in current and constant prices. Full balancing thus requires four main data sets, as well as three supporting sets of information, covering the current and constant price seasonal factors, together with prices. The seven data sets, in full, are:
- a. Current prices not seasonally adjusted;
  - b. Constant prices not seasonally adjusted;
  - c. Current prices seasonally adjusted;
  - d. Constant prices seasonally adjusted;
  - e. Current prices seasonal factors;
  - f. Constant prices seasonal factors;
  - g. Prices not seasonally adjusted.

- 11.43. Of these, the first four are to be balanced, with the information on seasonal factors and prices providing the 'link' between the various data sets. Data for the four main matrices can be assembled along the general lines outlined in the Annex 11 B, using largely independent sources and particular estimation methodologies.

It should be noted that the data set of prices included above relates to the original, non-seasonally adjusted data. Most prices are unlikely to be seasonal, and only a few like agricultural products will be strongly seasonal. However, it is for consideration whether a data set of seasonally adjusted price information should be established which would be appropriate to the relationship between the seasonally adjusted current and constant price estimates.

#### *The balancing steps in practice*

- 11.44. Although mention has been made earlier of the need to balance these matrices simultaneously, in practice some order to the process must be followed.

There are various arguments for and against each of the possible combinations of current/constant prices and non-seasonally/seasonally adjusted data. The main issues related to seasonally or non-seasonally adjusted data have been discussed in § 11.27-11.34.

In respect of the price dimension, the quarterly national accounts statistics will largely be based on current price information. Some direct measurement of constant price information will be possible as with volume measures of output, but more often estimates will need to be derived mostly by deflating the corresponding current price figures.

In practice, countries which undertake balancing adopt a variety of different approaches. For some, the starting point is the data set of current price, seasonally adjusted figures. For others, the emphasis is on the constant price, non-seasonally adjusted data. It is therefore not appropriate to recommend that balancing should be undertaken in a particular sequence. This decision should be left to individual countries in the light of the way they compile the accounts and depending on other issues at national level.

The key point is that, whatever sequence of adjustment is adopted, all four accounts (a to d in § 11.42) should be balanced. The description, here, of a possible balancing process will be based on the use of the current price, seasonally adjusted estimates (that is matrix c) as the starting point for balancing. The sequence for 'simultaneous' balancing might then run as described in the paragraphs which follow.

- 11.45. The initial balancing should be undertaken for the quarterly, current price seasonally adjusted figures. Once balance has been achieved, the balanced information should be deflated to yield a constant price seasonally adjusted array. This can be compared with the basic constant price seasonally adjusted figures (matrix d), from which a 'best' matrix of constant price seasonally adjusted is derived, based largely on the compilers' judgement.

The next step is to repeat the same procedures for the non-seasonally adjusted data. The whole process will yield four balanced and consistent matrices of national accounts data. These can be further examined for overall plausibility and further, expectedly small, adjustments made, as needs be. Some details of how the balancing might be achieved are set out below.

- 11.46. On the basis of the suggested framework and approach to data estimation set out in Annex 11.B, the first steps in the balancing process should be the comparison of:
- i) the first preliminary estimate of GDP with the estimates implied by the data in the tables;
  - ii) the estimates of supply and use for each product;
  - iii) the outputs and inputs of each industry, if available.

A further set of relevant 'structural' information will be provided by making estimates of the components of use for each product. This will be done by breaking down the total use according to the pattern of demand shown by the supply/use framework, for both the latest year and also the same quarter of a year earlier.

- 11.47. The quarterly balancing process should probably focus on balancing supply and use for each product, that is item (ii) above. This will involve a close assessment of the levels and growth rates of the individual series and their relative accuracy. It is of relevance to note that, for the quarterly figures, estimates of growth are likely to be more reliable than that of levels.

Consideration will need to be given also to deflators and seasonal factors. Some judgement will also be necessary on the comparison between the directly-measured information and that which can be estimated from the latest input-output framework. The use of other information from this latter source, for example ratios of output to value added and of taxes and margins to supply, is also an important part of the whole process.

- 11.48. The balancing exercise, particularly if it extends over a number of days, should be an iterative process, moving in stages to a level of GDP and a fully reconciled set of data, and consulting with data suppliers at each stage. The process needs to take into account the various constraints and criteria which need to be satisfied. Balancing at a detailed level may lead to adjustments which will revise the level of GDP established, provisionally, at the outset. This is a legitimate part of the balancing procedure.

#### *Key assumptions*

- 11.49. In using supply and use tables for quarterly balancing, a number of key assumptions need to be made.

The main ones involve determining, for each quarter, the industrial structure of (i) production and (ii) intermediate consumption, which are used as a basis for deriving product data from the estimates made for industries.

A third, similar assumption relates to the 'structural' estimates of final use derived from the supply/use framework. In the absence of any other information or evidence to the contrary, the structures of production, intermediate consumption and final sales of the previous year can be taken as obtaining for each quarter in the current year. Since changes in these structure will generally occur relatively slowly, this is likely to be a broadly acceptable assumption. However, as mentioned above, such assumptions will be much less pertinent for non-seasonally adjusted data than for seasonally adjusted figures. The reason for this is that seasonality in production and consumption will mean that the quarterly structure of the non-seasonally adjusted figures will be different from the annual structure. For the non-seasonally adjusted data, it will be necessary to consider the supply/use table for the same quarter a year earlier.

- 11.50. There are other points to be made about an assumption of stable economic structure.
- First, as discussed in Chapter 3, there may be certain industries where the industrial mix of outputs and inputs may vary over quarters in a way which, ideally, should not be ignored, even for the seasonally adjusted data. Thus, in deriving the various product-based estimates, it may be necessary in some quarters to modify the proportion shown by the previous year's tables.
  - A second issue, also discussed in Chapter 3, is that the ratio of intermediate consumption to output may vary significantly over the quarters of the year. The electricity industry was mentioned as an example where this problem might arise. Again this may need to be taken into account in deriving the figures of intermediate consumption, based on estimated output, for each industry.

## ***Retrospective balancing***

11.51. The procedures discussed above will lead to four sets of balanced accounts for the four quarters of a year. However, some time after these accounts have been derived, firmer annual data will become available for some of the variables, and the quarterly estimates will need to be aligned to the new annual figures. If time consistency is achieved largely independently for each variable, then the individual quarterly accounts will, most probably, need to be re-balanced. This can be done in two ways:

- if the process of alignment does not involve large or many changes, then it should be possible to modify the quarterly data manually;
- however, the more likely situation is that there will be many changes, some of which will be large, and, ideally, a full re-balancing will need to be undertaken. In principle, retrospective balancing may be seen as the same process which has been discussed earlier, but with the additional constraint that quarterly totals add to the known annual figures.

11.52. The above largely describes the theoretical position. In practice, in the absence of a computer program which can undertake balancing and alignment simultaneously (see § 11.57), it will be necessary to rebalance the aligned quarterly estimates manually. Given the amount of work which might be involved, it is worth observing that the 'annual' exercise is probably far less time-critical than that for the 'current' quarterly balancing. The end-product of the work is a set of quarterly accounts which are fully time consistent with the annual data.

In carrying out this process, it should be noted that the framework used for quarterly balancing is likely to be more aggregated than that used for the annual data.

One final issue for consideration where supply and use tables are used for quarterly balancing is whether the symmetric input-output matrices are also compiled each quarter.

## ***Alternatives to supply and use tables***

11.53. The procedures described above rely on the availability of annual supply and use tables to provide the basis for, and the framework within which, balancing can be undertaken. If such tables do not exist, there are other possible courses of action.

### *The supply and use oriented procedure*

11.54. The first and more likely course would involve some of the key stages of the methodology for the supply/use approach, as described above, but without the detail of the adjustment procedure. It may, for example, be possible to use the commodity flow approach for some commodities. The thrust of the approach might be built on the following two key stages:

- first, a figure for total GDP should be derived, by weighting together estimates from production, expenditure and income, as available;

- then, component data, at the aggregate level, for example household consumption, can be adjusted so that each of the (three) measures accords with the definitive GDP.

These adjustments are made by allocating the residual over these components, ideally in relation to their estimated accuracy. The approach can be undertaken for current and constant price data, and also non-seasonally adjusted and seasonally adjusted figures, again taking into account prices and derived seasonal factors. Clearly this approach lacks a definitive framework for the adjustment process and the ability to bring together and make consistent the detailed information on production and expenditure. However, in the absence of the supply and use information, it is certainly worth undertaking in some form or other.

#### *The institutional sector oriented procedure*

- 11.55. The second course would be to balance the estimates within the framework of the institutional sector analysis of transactions in products and the distributive and financial transactions.

Here, balance would be achieved at the level of the individual sector (or for the whole economy), through the two estimates of net borrowing/lending. These estimates are derived from, on the one hand, the production, expenditure and income data making up the production, distribution and use of income, and capital accounts, and on the other from the information on financial transactions. These estimates should be the same. In practice they are not the same, and balancing seeks to establish identity in the estimates derived from the two sources.

One way of proceeding would be first to establish a rough estimate for total GDP, as described above for the other methods, and also for net lending/borrowing, in the light of the accuracy of the two overall sets of financial and non-financial data. The various component series can then be adjusted to yield the net lending/borrowing figure (or something close to it). However, it is important that the adjustments lead to a derived measure of GDP which is not too far removed from the estimate established from the basic data. Again, the adjustments should be made on the basis of the relative accuracy of the component series.

It should be noted that this approach can be made only for current price data, since the financial information is not available at constant prices.

- 11.56. Two particular points should be made about this approach:
- there are certain disadvantages in endeavouring to balance data essentially on a figure of net lending or borrowing. Such a figure is the difference between various large numbers, and the errors in such data will feed through to the net balance. However, this concern will be largely mitigated by adherence to the constraint on GDP, as proposed above;
  - the data requirements of such an approach are, if anything, more demanding than what is needed for the supply/use method.

Further, it is likely that, before setting up a system of financial accounts, countries will wish to have established a satisfactory basis for measuring the real economy. Thus, financial accounts are unlikely to be widely available quarterly. As a consequence, in practice, this

kind of framework for balancing the accounts will generally be used in addition to, rather than instead of, the use of the input-output analysis.

### ***Balancing techniques***

- 11.57. There are various approaches which might be used for balancing, ranging from manual adjustment, through simple Random Allocation Sampling (RAS) techniques, to complicate mathematical procedures for dealing with large matrices. The manual approach relies, essentially, on the implicit judgement of the compiler to assess which particular series might be adjusted and by how much. The computerised methods will generally use a least squares estimation approach, perhaps subject to various constraints. The more sophisticated methodology might take into account the accuracy of the variables and incorporate correlations in the adjustment process, for example between dividends and interest receipts and financial flows.

Of the various techniques which have been used for balancing, one of the more recent is the approach which was undertaken, experimentally, in the United Kingdom before the use of annual input-output tables. The approach aimed to balance expenditure and income data on the one hand with financial data on the other, subject to certain constraints on aggregates.

The methodology is described in the United Kingdom publication "Economic Trends" No. 469, November 1992, which also provides references to literature describing other approaches.

- 11.58. As hinted above, one other point on the mechanics of balancing is whether a manual or computerised approach should be adopted. There are obvious benefits in the latter approach, particularly in reducing considerably the time needed for the work, and thus allowing more opportunity to examine and resolve problems with the data.

However, while computerisation might be possible for undertaking part of the balancing exercise, and to help with aspects such as graphics, it is unlikely that purpose-built software exists at present for carrying out the whole process. Thus, balancing will need to be undertaken manually, and the modus operandi of a systematic and iterative approach should be established. Although there should be a rigorous and objective basis for adjustment, the use of intuition and feel should certainly not be ruled out. Particular procedures will need to be developed in individual countries.

- 11.59. Where mechanical approaches are used, it is important that compilers scrutinise, very closely, the balanced figures and ensure that they are happy with the results. If adjusted figures look implausible, attempts should be made to find out why, and further, perhaps manual, adjustments made. One benefit of the manual approach is that it probably enables a better understanding to be obtained of the overall structure of the accounts and how they have been balanced. One possible procedure would be to have manual balancing for the

initial stages, during which time most the large adjustments which might be necessary to the figure will have been made. Then mechanical balancing can be introduced for the final stage.

- 11.60. Before moving on, it is important to re-iterate the point that the procedures described above represent, essentially, the theoretical approach to the balancing process. Their implementation, in full or even part, will need to be undertaken over a number of years, and will require much experimental work. It is desirable that countries draw up work programs on how they propose to move towards implementation of the quarterly balancing approach. It is also important that experiences of the work are shared between countries.

### ***Balancing by using mathematical and statistical methods***

- 11.61. Mathematical and statistical methods offer a sophisticated but very practical instrument to be used in the balancing procedure. They can be used in the balancing process to carry out the final steps in order to obtain the balanced estimates.

The use of these methods shall be considered in the general balancing process. This means that an exclusively mechanical use of the techniques outside of the process described in the previous paragraphs makes no sense in the compilation of the accounts.

- 11.62. According to the theoretical mathematical and statistical methods presented in Chapter 6, the balancing problem can be considered as a problem of estimation subject to temporal and accounting constraints. From a formal point of view, one is interested in estimating a number of individual variables starting from variables which are aggregated over units and time. This problem can also be treated by involving a system of variables rather than a single variable.

- 11.63. Several techniques have been developed to carry out balancing according to the mathematical and statistical methods. Two classes can be distinguished:
- a. methods that adjust multivariate preliminary estimates fulfilling the temporal and accounting constraints;
  - b. methods that use a set of quarterly indicators to obtain indirect estimates of the unknown aggregates.

Similarity to the univariate case presented in Chapter 6 is quite evident: the univariate two-steps method have their multivariate counterpart in (a), whilst optimal univariate methods correspond to (b).

In both classes, mathematical and statistical balancing techniques are conceived to obtain estimates that fulfil both temporal and accounting constraints. A formal presentation of mathematical and statistical methods which can be used in the quarterly balancing process will be found at Annex 11.A to this chapter.

### *Multivariate two-steps methods*

- 11.64. The starting point of multivariate two-steps methods is that a set of preliminary estimates for the aggregates of an account is available. The aggregates are subject to an accounting constraint that the preliminary series do not fulfil (e.g., the preliminary estimates for the components of GDP on the demand side do not sum to GDP, whose estimate has been obtained, for example, starting from output sources). Each series satisfied the temporal constraints (when annual figures are available).

The problem consists then in distributing, according to a suitable criterion, the discrepancy between the quarterly preliminary values and the expected accounting quarterly constraint (often represented by a quarterly series).

As in the univariate case, the distribution is made by minimising a quadratic loss function according to the same approach proposed by Denton, extended to the multivariate case (see Annex 11.A for more details).

### *Multivariate optimal methods*

- 11.65. As in the univariate case, the multivariate optimal approach supplies the estimates of a set of aggregates related by an account constraint according to a statistically optimal approach. The main idea is the same as in the univariate case: the related quarterly series are used in a multivariate regression model to obtain the estimation of the aggregate quarterly series with respect of both the temporal (versus the annual known aggregate series) and quarterly contemporaneous-accounting constraints (e.g. the constraint may correspond to the quarterly series of GDP).

The optimal multivariate estimation approach offers a natural and coherent solution to the interpolation, balancing and extrapolation problems.

- 11.66. The method derives from the univariate technique of Chow and Lin. Two different techniques have been developed, the difference being the structure of the error in the regression model. The two forms of the stochastic error process considered are:

- multivariate white noise;
- multivariate random walk.

The extrapolation is carried out according to the same principles of the univariate case: given the new values of the related series, the optimal nowcasts are directly obtained from the quarterly regression model.

## ***Some organisational issues of the balancing process***

- 11.67. The final part of the chapter looks at a number of other, non-statistical features of the balancing process, largely in response to some of the concerns which have been mentioned earlier. Some solutions are proposed to the problems raised, although the exact nature of

what is done will depend very much on the circumstances obtaining in individual countries. The main issues are:

- i) the general organisational arrangements for the carrying out balancing, including the involvement of compilers in the work;
- ii) the need to accommodate the process in the general timetable for preparing the quarterly estimates;
- iii) the education of users and others about the balancing process, including whether information on the adjustments should be made available outside the National Statistical Institute. Some other issues are also covered.

#### *Organisational arrangements*

- 11.68. On the organisational arrangements, the recommendation is to appoint a team dedicated to undertaking the balancing work. The precise nature of the responsibilities of the team should be made clear at the outset, in particular in relation to decisions about the way in which the adjustments are made. The team might undertake its work through a series of bilateral or wider discussions with compilers, in which issues related to their particular series and any possible adjustments can be considered. On the basis of these discussions, the team can assemble a further matrix of data, not necessarily fully balanced, but certainly exhibiting greater reconciliation than was evident in the initial estimates. This can then be discussed at a meeting of all interested parties. The meeting would seek to agree a final, balanced set of figures. Responsibility for final decisions on balancing, for example where there is disagreement about the size and location of adjustments, needs to be vested in one individual. As mentioned before, the whole process is essentially an iterative one, utilising, at each stage, the information available to try to form the optimum view of the overall economic position shown by the figures. In some cases balancing will be undertaken with a given set of data, in others new data may come to hand during balancing.
- 11.69. It is considered vital to use to the full the expertise of compilers in the balancing process. Their experience is crucial to the whole exercise, not only to improve the quality of the end-product, but also to enable them to get a wider perspective on the national accounts and how the economy is behaving. This enhanced knowledge should, itself, lead them to make improved estimates. Compilers should investigate particular problems which emerge at the various stages of the balancing process, discussing them, as appropriate, with the suppliers of the information, and seeking to achieve some resolution. Thus the suppliers, too, also have an important, perhaps indirect, part to play in the balancing round. This 'consultative' approach attempts to avoid simply taking information and adjusting it in a way with which compilers and suppliers would not necessarily agree and indeed may even wish to disown. However, it is useful for the national accountants to set quality standards for the information supplied to them, thereby reducing the burden on them of following up data problems with suppliers.

#### *The quarterly timetable*

- 11.70. One of the main practical issues is that the balancing process will be seen as, and almost certainly is, a potentially extremely time-consuming exercise, which is difficult to fit into an already tight quarterly timetable. Where balancing is not, at present, undertaken, or where it

is present but it can be improved, there will be a natural reluctance to delay publication of statistics to accommodate the extra work. However, the introduction or enhancement of the balancing process, with the associated improvement to the statistics, should involve some re-appraisal of the whole timetable for compiling the figures. This will, almost inevitably, raise the conflict between timeliness and accuracy of the national accounts statistics. One factor which is often underestimated is that an enormous amount of resources goes into collecting, compiling and bringing together all the data which make up the estimates. Balancing will be a relatively small part of the whole statistical process, but its role in ensuring that the information is assessed and used in the optimum way is of much greater importance. It is considered imperative that adequate time for the balancing work is included in the compilation round. If existing timetables cannot be changed, then the time required for balancing should be found from some other stage in the estimation process.

- 11.71. Balancing should appear as one of the final actions in the quarterly timetable. However, there is much merit in undertaking a preliminary balancing exercise earlier in the timetable to allow time for the investigation of particular problems, rather than leaving everything to the final stages. The appropriate place in the timetable for this first, exploratory assessment will depend on the flow of data, including the timing of the availability of certain monthly data (see below). It will also be essential to ensure that a reliable set of data can be assembled to make the balancing process worth while, although a preliminary look at figures will seldom go unrewarded. Thus, the stage at which preliminary balancing might be undertaken, and also what precisely might be done, will be a compromise between, on the one side, providing sufficient time to investigate and resolve any problems and, on the other, the quality of the data.
- 11.72. A number of problems are likely to arise in respect of monthly data which form the quarterly estimates, or the quarterly figures themselves, where such series are collected and published separately from the quarterly national accounts timetable. Two possible examples of such series are the monthly statistics of overseas trade and of industrial production. In particular, the timing of the availability of the relevant series could mean that data for two months or even complete quarters may already have been published before the balancing process for the quarterly accounts is undertaken. The inclusion of such series in the balancing exercise could well lead to the series being revised in the quarterly accounts fairly soon after they had been published in their own right.
- 11.73. In endeavouring to resolve this problem, two main considerations should be borne in mind. First, if a high priority is given to minimising revisions to data, the information which has recently been published should be included in the national accounts in this same form. In other words, such data are regarded as definitive for the balancing process, with no adjustments to them permitted. If, on the other hand, revisions are thought to be less important, then the estimates, although already published, can be considered for possible adjustment, in the usual way, as part of the balancing process. If appropriate, revised figures for the series will appear in the published quarterly accounts.
- 11.74. Before deciding on a particular course of action, as suggested above, a re-assessment should be made of the whole quarterly timetable. Consideration of this particular problem will raise the issue of the timeliness of the monthly data and the quarterly national accounts estimates. Specifically, one question which might arise is whether it is necessary to delay the timing of publication of key monthly data to ensure that the estimates can be considered in

the wider context of the full national accounts, and possibly be modified and improved. The solution to this problem must be left to individual countries, depending on the particular timing, availability and quality of the data. However, whatever timetable is adopted, it is desirable that, whenever national accounts data are published, be they monthly or quarterly figures, all the information available is assessed at the time of publication in order to determine the best estimates.

#### *Education of users and presentational issues*

- 11.75. Although balancing is only one part of whole estimation process, it is difficult to avoid it being regarded as a procedure of some special importance, with a special focus. This is likely to raise certain problems related to the need for, and nature of, the adjustment process, and also to the magnitude of the adjustments made.
- 11.76. One such problem is that the balancing process might be seen by some as a mean of manipulating the data, possibly at worst for political purposes. Such perceptions should be actively countered because they clearly put the whole statistical system into question. It is fundamental to the integrity of the national accounts statistics, indeed statistics generally, that users have confidence in the estimates and are adequately informed about the statistical processes. In respect of balancing, if there is a lack of understanding by users, it is a crucial responsibility of statisticians to explain clearly what is being done and the reasons why such adjustments are necessary. There should certainly be a document explaining why the adjustment process is needed and describing how it is undertaken. Information should also be disseminated through seminars and other formal and informal meetings. Incidentally, this mission to explain should not be confined just to users but should be extended to suppliers of data as well.
- 11.77. A second, in some ways related, issue is that users may wish to know the magnitude of the adjustments which are made as part of the balancing process. As was mentioned earlier in this chapter, balancing is essentially the final stage in what can be regarded as a continuum of adjustment needed to compile the national accounts. If an indication is required about the adjustments being made to data, it is arguable where to draw the line in the whole estimation process. Limiting the indication to the adjustments made during balancing is a convenient, though still arbitrary, decision. In reality, the provision of information of this kind does little more than indicate the quality of the data underlying the national accounts. It might be inferred that, the smaller the adjustments, the better the overall quality of the data. However, this will not be the case if, for example, the estimates contain larger adjustments which are made before the balancing process. Further, providing details of adjustments is tantamount to having the equivalent of two sets of national accounts data in circulation at the same time. Although the basis and other relevant features of the two data sets could be explained, it is inevitable that there would be misinterpretation or misuse of the information.
- 11.78. Given all these considerations, it does not appear that there would be much to be gained from making information on the balancing adjustments generally and widely available. However, it should be recognised that there is likely to be some value in restricted dissemination of the information. For example, compilers will benefit from discussions of the details of the balancing process with experts outside the National Statistical Institute. There is also the important consideration that, if information on the adjustments was denied totally,

it is likely that suspicions would be aroused on the probity of the estimation process. It is suggested, therefore, that, in addition to giving such information to outside experts, it is also provided to meet strong and bona fide requests made by others. However, as far as possible, to limit potential misunderstanding, the material should be provided for personal rather than general use. All releases of such material should be accompanied by a short description on any key points related to the particular quarter, together with some indication of the accuracy of the data being adjusted.

### *Other*

11.79. Finally and briefly there are a few other issues worth raising. To begin with, the balancing process has a number of important implications for the statistical system.

- One particular consequence is that regular balancing, with all series being reviewed, may lead to more revisions to data than hitherto. The revisions policy adopted will need to determine how this is to be dealt with.
- Secondly, it is vital to learn lessons from the balancing exercise about the general quality of the estimates. The process should include investigation into the main problem areas in the accounts, with reasons for inconsistencies being pursued.
- Further, attempts should be made to improve the quality of the basic information identified as weak by changes in collection or estimation practices.
- Finally, where balancing is being introduced for the first time, or major improvements are being made to existing practices, it will be very sensible to have a trial run of procedures before using the process to generate the published statistics. If possible, changes to time-tables might also be tested before being actually implemented.

### **Summary**

11.80. It will be useful to bring together the main principles and issues related to balancing, as discussed in this chapter.

First, the four key general principles are:

- i) there should be a single, definitive estimate of GDP (see § 11.09);
- ii) full balancing should be undertaken, that is no statistical discrepancies should remain in the estimates (see § 11.09-11.12);
- iii) all variables should be subject to possible adjustment (see § 11.13-11.14);
- iv) quarterly balancing should be undertaken for current and constant price estimates, and also non-seasonally adjusted and seasonally adjusted data (see § 11.25, 11.44-11.45).

11.81. Secondly, there are a number of general statistical issues:

- i) balancing of information on production, expenditure and income should be undertaken through the framework of the supply/use or input-output tables. It may also be

possible to use the structure of the institutional sector accounts, incorporating, in addition, information on financial transactions (see § 11.04 and 11.39);

- ii) the basic data included in the balancing process should, as far as possible, be free of measurement bias (see § 11.24 and 11.35);
- iii) balancing for a given period also needs to take account of growth rates and the time series nature of the variables (see § 11.23);
- iv) adjustments should be made not only to the basic national accounts variables, but also to the information on prices and seasonal factors (see § 11.25, 11.33, 11.42-43);
- v) adjustments should be based on the estimated accuracy of the component data, and should not generally fall outside the estimated error range (see § 11.18-11.20);
- vi) the appropriateness of the information included in the balancing process which based on the previous year's framework needs to be carefully assessed, particularly for the non-seasonally adjusted data (see § 11.22, 11.31-11.32, 11.49-11.50);
- vii) quarterly balanced matrices should be made consistent with the firmer annual data (see § 11.51-11.52);
- viii) the introduction of balancing may necessitate some modification of the policy on revisions (see § 11.79).

11.82. Thirdly, the main operational issues are:

- i) countries should draw up a work programmes on the introduction of quarterly balancing procedures (see § 11.60);
- ii) arrangements and responsibilities for the balancing work should be clearly established, with the compilers having a key role (see § 11.68-11.69);
- iii) the balancing process is a complex operation and sufficient time must be allowed for it in the quarterly timetable (see § 11.70-11.74);
- iv) the need for and nature of the balancing process must be clearly communicated to users (see § 11.75-11.78);
- v) major changes to procedures should be trialled before being formally introduced (see § 11.79).



**CHAPTER 11 - Annex A**

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**BALANCING BY USING MATHEMATICAL AND STATISTICAL  
MODELS**

## Balancing by using mathematical and statistical models

### A formal presentation

- 11.A.01. Following the notation of the annex to Chapter 6, detailed consideration is given here to the mathematical approach to the disaggregation and extrapolation problems in the multivariate context of the balancing problem.

To be estimated are  $M$  unknown  $1 \times n$  vectors of quarterly data,  $\mathbf{y}_j$ ,  $j=1, \dots, M$ , each pertaining to one of  $M$  basic (i.e. disaggregated) time series which have to satisfy both contemporaneous and temporal aggregation constraints.

- 11.A.02. The solution of this problem entails consideration of a number of procedures that, as in the single variable case, can be characterised as either *pure adjustment* or *least-squares optimal*. The information set common to both cases is given by the following  $M+1$  aggregated vectors:

- $\mathbf{z}$ ,  $1 \times n$  vector of quarterly contemporaneously aggregated data;
- $\mathbf{y}_{ja}$ ,  $J=1, \dots, M$ , ( $n \times 1$ ) vectors of annual data.

- 11.A.03. Consider the two distinct situations:

- a.  $M$  preliminary quarterly time series,  $\mathbf{p}_j$ ,  $j = 1, \dots, M$ , are available,

Where  $\sum_{j=1}^M \mathbf{p}_j = \mathbf{z}$  and/or  $\mathbf{B} \mathbf{p}_j = \mathbf{y}_{ja}$ ;

- b. a set of quarterly related indicators is used to obtain indirect estimates of the  $M$  unknown time series.

The distinction is not necessarily as strict as it seems, in that preliminary quarterly series could have been individually obtained by using related indicators.

- 11.A.04. Assuming that each basic series satisfies a multiple regression relationship with a number of known related indicators, a least-squares optimal solution, consistent with the aggregation constraints, can be obtained. This approach will be developed by discussing some specific error covariance pattern.

Consider the  $n \times 1$  vector

$$\mathbf{y}_0 = \begin{matrix} \mathbf{z} \\ \mathbf{y}_a \end{matrix}$$

where

$$\mathbf{y}_a = \begin{matrix} \mathbf{y}_{1a} \\ \mathbf{y}_{2a} \\ \vdots \\ \mathbf{y}_{Ma} \end{matrix}$$

The following accounting constraints hold:

$$\sum_{j=1}^M \mathbf{y}_j = \mathbf{z},$$

$$\mathbf{B} \mathbf{y}_j = \mathbf{y}_{ja}, \quad j=1, \dots, M.$$

The complete set of constraints between the series to be estimated and the available aggregated information can be expressed in matrix form as

$$\mathbf{H} \mathbf{y} = \mathbf{y}_0$$

where

$$\mathbf{H} = \begin{pmatrix} \mathbf{1}'_M & \mathbf{I}_N & \mathbf{H}_1 \\ \mathbf{I}_M & \mathbf{B} & \mathbf{H}_2 \end{pmatrix},$$

$\mathbf{1}'_M$  is a  $1 \times M$  vector, all elements of which are equal to unity and

$$\mathbf{y} = \begin{matrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{matrix}.$$

11.A.05. Note that the contemporaneous aggregation of temporally aggregated series implies

$$\sum_{j=1}^M \mathbf{y}_{aj,t} = \sum_{i=1}^4 \mathbf{z}_{4t-1-i} + \mathbf{z}_{a,t}, \quad t=1, \dots, n,$$

and then, given this relationship between the  $M+1$  aggregated vectors, matrix  $\mathbf{H}$  has rank  $r = n - 1$ ,  $n$  aggregated observations being redundant.

### Multivariate adjustment

11.A.06. Suppose we have  $M$  preliminary series,  $p_j, j=1, \dots, M$ , that need to be adjusted in order to satisfy the accounting constraints. This has to be accomplished by distributing the discrepancies

$$\mathbf{z} - \mathbf{H}_1 \mathbf{p}$$

and

$$\mathbf{y}_0 - \mathbf{H}_2 \mathbf{p},$$

where

$$\mathbf{p} = \begin{pmatrix} \mathbf{p}_1 \\ \vdots \\ \mathbf{p}_j \\ \vdots \\ \mathbf{p}_M \end{pmatrix},$$

according to some reasonable criterion. In the following we deal with two multivariate adjustment procedures: (i) proportional adjustment; (ii) Denton's multivariate adjustment.

- 11.A.07. The proportional adjustment procedure is very simple and widely used, although less generally applicable than the Denton method, because it assumes only contemporaneous constraints have to be fulfilled (that is,  $\mathbf{B}\mathbf{p}_j = \mathbf{y}_{aj}$ ,  $j=1, \dots, M$ ).
- 11.A.08. A simple and fairly reasonable way to eliminate the discrepancy between a contemporaneously aggregated value and the corresponding sum of disaggregated preliminary quarterly estimates consists in distributing such a discrepancy according to the weight of each single temporally aggregated series with respect to the contemporaneously aggregated one.
- 11.A.09. Denton's multivariate adjustment generalises the univariate procedure shown in § 6.A.13 by taking into account some technical devices about (i) the treatment of starting values (Cholette, 1984, 1988) and (ii) the nature of the accounting constraints.

### **Multivariate optimal estimation**

- 11.A.10. If there exists a set of quarterly indicators related to the unknown disaggregated series, it is possible to specify  $M$  regression models

$$\mathbf{y}_j = \mathbf{X}_j \mathbf{u}_j, \quad j=1, \dots, M$$

with

$$\mathbf{u}_j \geq 0, \quad \mathbf{u}_i \mathbf{u}_j' = \mathbf{V}_{ij}, \quad i, j=1, \dots, M,$$

where,  $\mathbf{X}_j, j = 1, \dots, M$ , are  $n_j$  matrices of related series. The  $M$  models can be grouped as follows:

$$\begin{pmatrix} \mathbf{y}_1 \\ \mathbf{y}_2 \\ \vdots \\ \mathbf{y}_M \end{pmatrix} = \begin{pmatrix} \mathbf{X}_1 & 0 & \dots & 0 \\ 0 & \mathbf{X}_2 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & \mathbf{X}_M \end{pmatrix} \begin{pmatrix} \mathbf{u}_1 \\ \mathbf{u}_2 \\ \vdots \\ \mathbf{u}_M \end{pmatrix},$$

or, extending the notation used in § 11.A.05,

$$\mathbf{y} = \mathbf{X} \mathbf{u}$$

where  $\mathbf{u} = 0$  and,  $\mathbf{u}\mathbf{u}' = \mathbf{V} = (V_{ij})$ ,  $i, j = 1, \dots, M$ .

11.A.11. The observed, aggregated regression model is given by:

$$\mathbf{y}_0 = \mathbf{X}_0 \mathbf{u}_0$$

Where  $\mathbf{X}_0 = \mathbf{H}\mathbf{X}$ . The aggregated disturbance vector,  $\mathbf{u}_0 = \mathbf{H}\mathbf{u}$ , has zero mean and singular covariance matrix  $\mathbf{u}_0\mathbf{u}_0' = \mathbf{V}_0 = \mathbf{H}\mathbf{V}\mathbf{H}'$ .

11.A.12. The quarterly estimates can be obtained as a solution of a linear prediction problem in a generalised regression model with singular covariance matrix (Di Fonzo, 1990):

$$\hat{\mathbf{y}} = \mathbf{X}' \mathbf{L} \mathbf{y}_0 - \mathbf{X}' \mathbf{V}_0^{-1} \mathbf{X}_0' \mathbf{V}_0^{-1} \mathbf{X}_0' \mathbf{y}_0,$$

$$\hat{\mathbf{y}} - \mathbf{y} = \hat{\mathbf{y}} - \mathbf{y}' = (\mathbf{I}_N - \mathbf{L}\mathbf{H}\mathbf{V} \mathbf{X} - \mathbf{L}\mathbf{X}_0' \mathbf{X}_0' \mathbf{V}_0^{-1} \mathbf{X} - \mathbf{L}\mathbf{X}_0')$$

With  $\mathbf{L} = \mathbf{V}\mathbf{H}'\mathbf{V}_0^{-1}$ , where  $\mathbf{V}_0^{-1}$  is the Moore-Penrose generalised inverse of the singular matrix  $\mathbf{V}_0$ . The above relationships are natural extensions of the optimal univariate counterparts worked out by Chow and Lin (1971).

11.A.13. In practice, matrices  $\mathbf{V}_{ij}$  are unknown and must be estimated according to proper assumptions on the  $\mathbf{u}_j$ 's. Two cases seem to be interesting from both a theoretical and a practical point of view: (i) multivariate white noise; (ii) multivariate random walk.

11.A.14. In the multivariate white noise case we assume

$$\mathbf{u}_i \mathbf{u}_j' = \delta_{ij} \mathbf{I}_N, \quad i, j = 1, \dots, M,$$

$$\mathbf{u}\mathbf{u}' = \mathbf{I}_N,$$

The elements of  $\mathbf{V}_{ij}$  can be estimated using the ordinary least squares residuals of the temporally aggregated regressions  $\mathbf{y}_{aj} = \mathbf{X}_{aj} \mathbf{u}_{aj}$ . Furthermore, in this case the inversion of  $\mathbf{V}_0 = \mathbf{H}\mathbf{V}\mathbf{H}'$  can be notably simplified: by a suitable partition of  $\mathbf{V}_0$ , only a  $(r-1) \times (r-1)$  matrix needs to be inverted (Di Fonzo, 1990).

11.A.15. The multivariate random walk case is a straightforward generalisation of the univariate approach of Fernández (1981). This model is based on the following assumptions:

$$u_t = u_{t-1} + \epsilon_t, \quad t = 1, \dots, T,$$

$$u_0 = \mathbf{O}, \quad \epsilon_t = \mathbf{O},$$

$$\epsilon_r \epsilon_s' = \begin{cases} 0 & \text{if } r \neq s \\ \sigma_{rs} & \text{if } r = s \end{cases}, \quad r, s = 1, \dots, M,$$

where  $\mathbf{u}_t$  and  $\mathbf{v}_t$  are  $1 \times r$  contemporaneous disturbances vector. These assumptions imply  $E(\mathbf{u}_t) = \mathbf{0}$  and  $E(\mathbf{u}_t \mathbf{u}_s') = \min(r, s) \mathbf{I}$ , that is  $\mathbf{u} \mathbf{u}'$ , where  $\mathbf{u}$  can be estimated as in the multivariate white noise approach.

### Extrapolation

- 11.A.16. When  $4n$  we need to estimate data for which the relevant temporally aggregated values are not available. In this case it has to distinguish whether the contemporaneously aggregated information is or is not available. In the former case we talk about *constrained extrapolation* while in the latter we have a *pure extrapolation* problem. In both cases we look for the best linear unbiased estimator of

$$\mathbf{y}_{j,4n+i} = \mathbf{X}_{j,4n+i} \boldsymbol{\beta}_j + \mathbf{u}_{j,4n+i}, \quad j=1, \dots, M, \quad i=1, \dots, r,$$

where  $\mathbf{X}_{j,4n+i}$  is a  $1 \times j$  vector of the  $K_j$  related indicators for the  $j$ -th series at time  $4n+i$  and  $\mathbf{u}_{j,4n+i}$  is a zero mean unobservable random error.

- 11.A.17. In the pure extrapolation case the parameter vector need not be re-estimated, the extrapolation being given by a straightforward multivariate generalisation of the univariate solution shown in § 6.A.26.
- 11.A.18. If a contemporaneously aggregated series is available, the complete set of estimates must instead be re-calculated (Di Fonzo, 1990).