Chapter 6. The balancing procedure and main approaches to validation

6.1 Supply and use tables as a framework for balancing the functional national accounts

6.1.1 Definitions

A *supply table* is a matrix whose row dimension is the number of products specified in the economy as depicted by the national accounts and whose column dimension is the number of domestic industries plus one column representing imports. If n is the number of products and m is the number of industries, the supply table is a matrix of dimension n x (m+1). The table has positive row entries corresponding to all sources of supply of a given product.

A *use table* is a matrix whose row dimension is the number of products specified and whose column dimension is the number of industries plus the number of final use categories (types of final consumption, gross capital formation, exports). If q is the number of final use categories shown, the use table is a matrix of dimension n x (m+q).

The above general definitions are apparently very straightforward. In reality, however, the world is not as simple as that, because supplies and uses of products are recorded at different price levels depending on where in the production and distribution chain the transactions are observed and recorded. It is very important when talking about supply and use of products to be aware of whether the values recorded are inclusive of trade and transport margins on the one hand and taxes and subsidies on products on the other.

The two main price level concepts of the SNA are basic prices and purchasers' prices including non-deductible VAT. GDP at market prices can be derived and presented as final uses (consumption, gross capital formation and exports) at purchasers' prices including non-deductible VAT less total imports. The term "market prices" is in fact shorthand for purchasers' prices including non-deductible VAT. The two price level concepts are defined as follows:

Basic prices:
The basic price is the amount receivable by the producers from the purchaser for a unit of a good or service produced as output minus any tax payable on that unit as a consequence of its production or sale (i.e. taxes on products), plus any subsidy receivable on that unit as a consequence of its production or sale (i.e. subsidies on products). It excludes any transport charges invoiced separately by the producer. It includes any transport margins charged by the producer on the same invoice, even when they are included as a separate item on the invoice. (ESA 3.48).

When output is recorded at basic prices, any tax on the product actually payable on the output is treated as if it were paid by the purchaser directly to the government instead of being an integral part of the price paid to the producer. Conversely, any subsidy on the product is treated as if it were received directly by the purchaser and not the producer. The basic price measures the amount retained by the producer and is, therefore, the price most relevant for the producer's decision-making. It is

becoming increasingly common in many countries for producers to itemise taxes separately on their invoices so that purchasers are informed about how much they are paying to the producer and how much as taxes to the government. (SNA 6.206).
In the supply table, imports are valued c.i.f..

Purchasers' prices (including non-deductible VAT):
At the time of purchase, the purchaser's price is the price the purchaser actually pays for the products, including any taxes less subsidies on the products (but excluding deductible taxes like VAT on the products); including any transport charges paid separately by the purchaser to take delivery at the required time and place; after deduction for any discounts for bulk or off-peak purchases from standard prices or charges; excluding interest or service charges added under credit arrangements; excluding any extra charges incurred as a result of failing to pay within the period stated at the time the purchases were made. (ESA 3.06).

An economist unfamiliar with national accounting concepts might perhaps ask why the national accounts need such complicated rules regarding the valuation of products. Why does the System not just record all transactions at market prices understood as purchasers' prices including non-deductible VAT? The answer is first of all that in many cases a purchase of a good by the final user involves not one but several transactions - for instance, a sale from the original producer to a wholesaler, a sale from the wholesaler to a retailer and finally a sale from the retailer to the final purchaser. Secondly, as remarked above, the price relevant for a producer in his decision-making is the basic price and not the price paid by the final purchaser.

The reasons the SNA gives prominence to the concept of basic prices in the description of the production process can be summarised as follows:

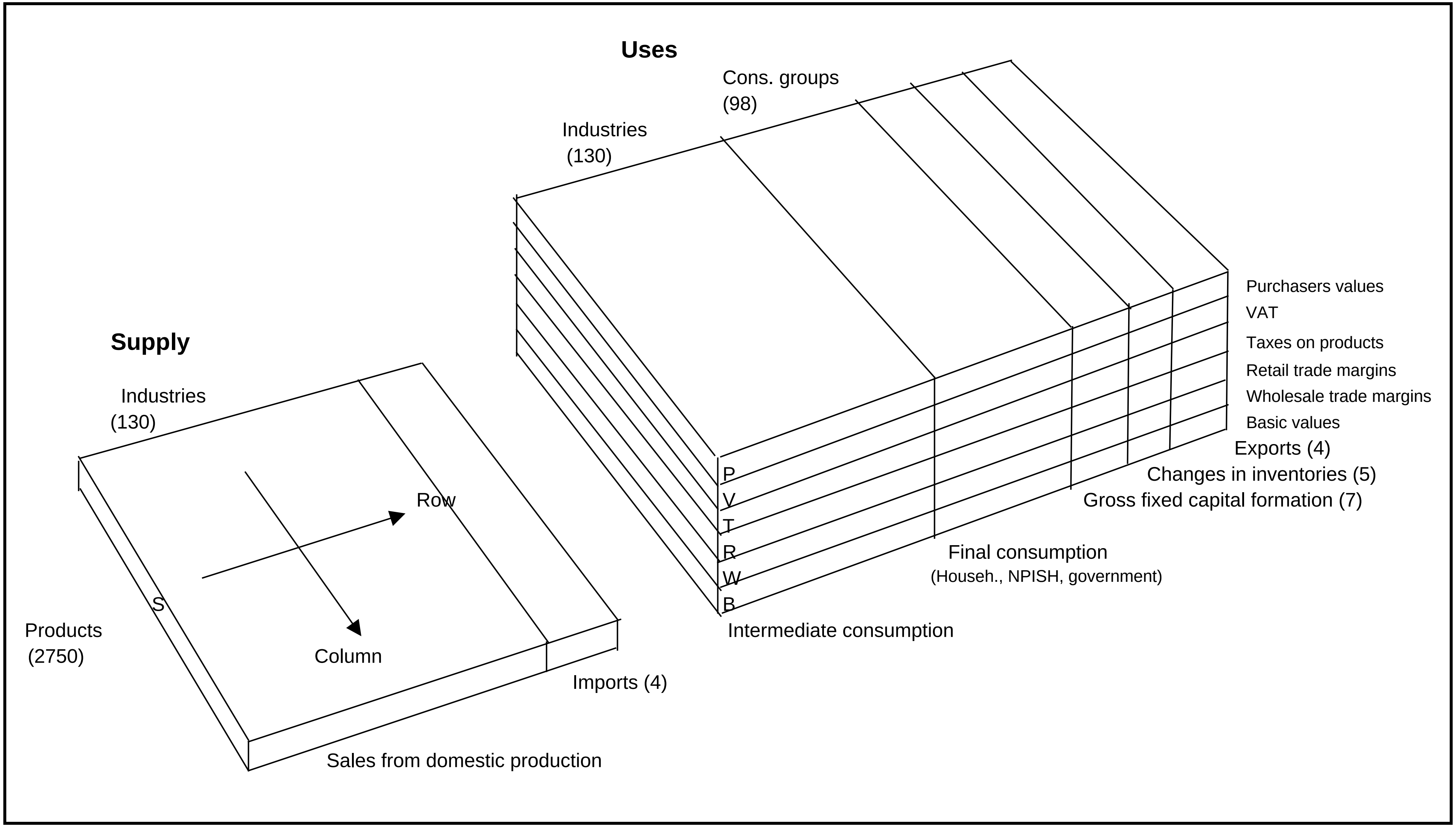
- It is the price concept relevant for the producer and hence for economic analysis of production
- It is the price concept which is likely to feature in business accounts that often serve as the starting point for filling out statistical questionnaires. It is thus observable.
- Linear economic models (applied input-output analysis) require the values in dollars of the different uses of a product to approximate as closely as possible to the physical quantities of the product used. This price homogeneity is best achieved by recording uses of products at basic prices.

A set of supply and use tables therefore contains not one but several use tables.

S (n x (m+1)) supply matrix at basic prices (c.i.f. values for imports)
B (n x (m+q)) use table at basic prices
W (n x (m+q)) use table for wholesale trade margins
TR (n x (m+q)) use table for transport margins
R (n x (m+q)) use table of retail trade margins
T (n x (m+q)) use table of taxes less subsidies on products except VAT
V (n x (m+q)) use table of non-deductible VAT
P = B+W+TR+R+T+V
(n x (m+q)) use table at purchasers' prices including non-deductible VAT) (f.o.b. values for exports).

These tables are illustrated in figure 13 which, for simplicity, merges tables W and TR. In the Danish national accounts, W and TR are merged as described in Section 3.12.5**.** Figure 13 illustrates the number of products, industries and final use categories in the Danish supply and use tables.

Figure 13 Supply and use tables in the national accounts



6.1.2 The place of supply and use tables in the system of national accounts

The supply and use tables are directly linked to the first three accounts of the system of accounts for the total economy, viz. the goods and services account, the production account and the generation of income account. They are merely a two-way breakdown of these accounts. The first dimension in the breakdown is products, the second is industries and components of final uses.

6.1.3 Supply and use tables and the compilation of national accounts

6.1.3.1 A powerful tool for integrating GDP(O) and GDP(E) plus to some extent GDP(I)

GDP is generally considered to be the most important aggregate in the national accounts. Determining GDP so that this statistical measure of production is both exhaustive and reliable is one of the most demanding tasks facing national accountants.

The key to achieving exhaustive and reliable estimates of GDP lies, apart from the existence of up-to-date registers or censuses enumerating the total population of producer units, in the systematic confrontation of the various primary statistics underlying different components of GDP. The essence of such a confrontation of statistical sources is that estimates derived using one set of estimates are cross-checked against alternative estimates of the same item derived using other sources. An example of such cross-checking could be a validation of the estimate of final household consumption of food in the national accounts using alternative estimates derived in 3 different ways:

1. based on household budget surveys adjusted for tourist expenditures;
2. based on retail sales of food adjusted for own-account consumption;
3. based on total output of food plus imports less estimated intermediate consumption less changes in inventories less exports.

The national accounts estimate finally retained after such a validation will clearly be more firmly based than one that relies exclusively on a single set of sources.

It is well known that GDP can be derived from three different angles, namely production, expenditure and income.

In the production approach, GDP derived from the output side, GDP(O), can be written as:

GDP(O) = output at basic prices - intermediate consumption at purchasers' prices
including non-deductible VAT + taxes on products, net1)

Taxes on products, net, means taxes on products less subsidies on products. Non-deductible VAT is part of taxes on products.

If VA_i denotes value added at basic prices of industry i (i.e. output at basic prices less intermediate consumption at purchasers' prices including non-deductible VAT), equation (1) can be rewritten as:

$$GDP(O) = \sum_i VA_i + taxes\ on\ products\ less\ subsidies\ on\ products \quad 2)$$

(2) says that GDP equals the sum of industry value added plus the total of taxes less subsidies on products.

In the expenditure approach, GDP(E) is derived as:

GDP(E) = final consumption + gross capital formation + exports - imports (3)

(3) says that GDP equals final national uses plus net exports.

Finally, in the income approach, GDP(I) is derived as:

GDP(I) = compensation of employees + gross operating surplus/mixed income (4)
+ taxes on production and imports less subsidies.

(4) says that GDP equals the sum of primary incomes in the economy, i.e. wages etc., profits in a broad sense plus taxes less subsidies on production and imports.

Note that (1) includes the item "taxes on products less subsidies on products", i.e. net taxes on production which are linked to the quantity or value of output, whereas (4) contains the item "taxes less subsidies on production and imports", which consists of *all* taxes, net, on production and imports. Taxes and subsidies on production consist of taxes/subsidies on products, which are those directly linked to the volume or value of output, and of other taxes/subsidies on production e.g. taxes on property and employment subsidies that are not directly linked to the volume or value of output.

As mentioned above, an important aspect of the quality of GDP estimates is the opportunity for cross-checks implied by equations (1), (3) and (4). Other things being equal, a GDP estimate which is based on two or three approaches will be more reliable than one which basically relies on a single approach. However, the statistical value of the confrontation of the three approaches depends on the independence or autonomy of the estimates derived from the three sides. If, for instance, final national uses are largely derived as residuals for product groups from the equation: final national uses = output plus imports less intermediate consumption less exports, the expenditure approach, even though it is present from a purely formal point of view, does not really corroborate the estimate of GDP derived from the production side. Conversely, if industry value added is estimated to a large extent from information on gross output by branch, and, for lack of information, intermediate consumption ratios by industry are fixed so as to make the resulting value added tally with final uses, the output measure of GDP has virtually no autonomy. The output measure of GDP cannot in that case be said to validate the expenditure measure. The same reasoning applies with respect to GDP(I).

Exploitation of the powerful checks on the level and evolution of GDP implied by the accounting relationships (1), (3) and (4) therefore presupposes a high degree of independence or autonomy between the statistical sources and methods underlying the three initial estimates of GDP namely GDP(O), GDP(E) and GDP(I). Since the system of national accounts requires estimates to be drawn up for all the income and expenditure components of GDP, almost any country with a set of national accounts will be able to *present* GDP from the three different angles. That, however, is not the same thing as actually *deriving* GDP from all three angles. Most OECD countries are currently in a position to estimate GDP from two angles. Some, including Denmark, have gone further and draw up initial estimates from all three sides before proceeding to an integration of these initial estimates into a single official GDP figure.

Given that GDP(O), GDP(E) and GDP(I) will not coincide, except by chance, the question arises as to how these three measures should be integrated into a single compromise measure of GDP which will be retained as the official figure. Looking first at the balancing or integration of GDP(O) and GDP(E), it must be observed that the difference between the two equals the difference between the initial estimate of total supply and the initial estimate of total uses of goods and services in the economy. The problem of integrating or balancing GDP(O) and GDP(E) is therefore equivalent to balancing total supply and total uses in the economy.

At the one extreme, this balancing can be done at the macro level. In some countries where largely independent estimates are compiled for GDP(O) and GDP(E), the official GDP measure is fixed as max{GDP(O), GDP(E)} on the grounds that the lower figure is likely to have omitted some production. Alternatively, the official GDP measure could be fixed somewhere between the two, depending on the statisticians' informed opinion of the relative uncertainties involved. This method may be termed the macro integration method. If so-called statistical discrepancies are to be avoided, the discrepancies between the initial estimate of GDP(O) and the GDP finally retained must be broken down by industry. By the same token, the discrepancy between the initial GDP(E) estimate and the official GDP measure must be assigned to particular expenditure components.

An intermediate strategy is to balance the accounts by looking at supply and use for broad categories of products, for instance by end-use categories. The systematic application of this method consists in using an updated input-output table from the previous year or some benchmark year as integrating framework. This approach is currently used in some of the EU countries. Again, it is necessary to assign the initial differences to particular value added and expenditure components in order to avoid inconsistent accounts containing unexplained statistical discrepancies. This approach may be called the intermediate level balancing method.

Finally, the most systematic way of balancing GDP(O) and GDP(E) is to proceed product by product. When equilibrium in the resources-uses balances is achieved for all products by adjusting the initial estimates of supply and intermediate plus final uses, the macro discrepancy between total supply and total use of goods and services, and hence between GDP(O) and GDP(E), will be eliminated in the process. The result is a single GDP figure with no unexplained statistical discrepancies. This integration method is the supply and use table method (sometimes called the commodity-flow or product-flow method). It implies that supply and use tables are drawn up each year as an integral part of the production of national accounts. This in turn implies that symmetric input-output tables are available for current years and not just for benchmark years.

In Europe, the supply and use table integration method is currently used in a few countries including France, the Netherlands and Denmark. Some other countries have adopted a similar approach, albeit at a more aggregate level corresponding to the level of aggregation in input-output tables. Finally, in a number of countries the supply and use table integration method has been used in establishing the benchmark for the national accounts, but not in current years where more aggregate balancing is applied. The ESA95 Regulation now requires all EU countries to draw up supply and use tables every year from the reference year 1995 onwards and with the data transmission starting in 2002. The minimum level of detail required is 60 products and 60 industries. It seems likely that the requirements of the ESA95 data transmission programme will lead an increasing number of European countries to move towards the supply and use table framework for integrating GDP(O) and GDP(E), at least for benchmark years.

The supply and use table framework understood as a product by product balancing process is the most systematic way to attain consistency between initial estimates of GDP(O) and GDP(E). This leaves the role of GDP(I). Since GDP(I) has no direct counterpart in terms of products, its link with supply and use tables is much less direct than is the case with GDP(O) and GDP(E). Even so, GDP(I) is naturally integrated into the same framework. To see this, take the case of the GDP(I) component compensation of employees. Suppose that estimates of compensation of employees by industry are available from tax or social security records, say. If, when balancing GDP(O) and GDP(E) using the supply and use table approach, one arrives at an estimate of value added in industry i which, combined with the figures for wages etc. from the tax sources, leaves a suspiciously small (or large for that matter) value for gross operating surplus and mixed income, there is clearly a problem in the accounts. In that case the information contained in components of GDP(I) reveals a need to review the value added estimate resulting from the integration of GDP(O) and GDP(E). In particular, it will be necessary to compare compensation of employees as calculated from the accounts of producer units (the outlays of producers) with compensation of employees as recorded for wage-earners in the tax files (income of wage-earners). However, since the strength of the supply and use table framework features most clearly in the integration of GDP(O) and GDP(E), the question of the role of initial estimates of GDP(I) will not be pursued further in this context.

6.1.3.2 The supply and use table framework: rationale and limitations

Over the past couple of decades, a consensus has emerged at the international level that the supply and use table approach is the ideal framework for integrating components of GDP derived from different angles. The rationale for the supply and use table approach is basically a common sense argument: given that cross-checks of components of GDP derived from different angles are valuable in ensuring the quality of official GDP figures, obviously the more detailed the level at which these checks can be carried out the better.

This common sense argument may be elaborated to demonstrate that the strength of balancing the national accounts at the product level shows up not only for the final national accounts at current prices but for national accounts at constant prices and provisional and quarterly accounts as well. The main strengths of the detailed product approach may be summarised in the following points:

(1) Exploitation of links between discrepancies between supply and use of products and specific categories of uses.

Given an initial deviation between GDP(O) and GDP(E), it is difficult to know to which components to assign this discrepancy and thus which of the initial estimates to modify. Knowing which products account for the major part of the macro discrepancy, on the other hand, yields a strong indication of which components to modify. Example: suppose that GDP(O) is higher than GDP(E), and that a significant part of the macro difference is due to an apparent surplus of consumer durables. In that case, after verification of domestic production, intermediate consumption, imports and exports, it will be obvious that we should consider adjusting the initial estimates for final household consumption of consumer durables and possibly also gross fixed capital formation in these products. Conversely, suppose that GDP(E) is higher than GDP(O) and that there is an apparent deficit of consumer durables in the economy. Assume further that the initial estimate of final household consumption is (partly) based on a household budget survey of good quality. In that case it will be necessary to investigate the exhaustiveness of the production and import figures for consumer durables as well as the trade margins involved. In both cases, knowledge of which product groups are behind the macro discrepancy is of great use for achieving consistency in the national accounts.

(2) Exploitation of knowledge of the technical nature of products.

Many products are used exclusively or predominantly for certain specific uses by virtue of their technical nature. Knowing the domestic supply of individual products therefore serves as a check on the intermediate consumption ratios and cost structures (technical coefficients) compiled in industrial surveys. Example: if the domestic supply of cement does not tally with the input of cement into the construction industry estimated on the basis of technical coefficients derived from industrial surveys, the statistical sources on the supply and uses sides are inconsistent, and one of them needs to be amended. Knowing the product detail pinpoints a statistical problem, which might otherwise have gone unnoticed.

(3) Filling gaps caused by lack of basic statistics.

Most countries are likely to have gaps in their coverage in basic statistics of some components of GDP. In the national accounts, an estimate will, of course, have to be drawn up anyway. Exploiting the logic of the accounting system, i.e. the accounting identities of the system, in conjunction with knowledge of the products involved frequently enables solid estimates to be made in the absence of basic statistics. Example: suppose that the basic statistics needed to estimate gross fixed capital formation from the expenditure side (part of GDP(E)) are not available. Even countries that do not rely on the supply and use table approach as the framework for integrating their national accounts often exploit the commodity flow approach in order to estimate investment in machinery and equipment.

(4) Ideal basis for drawing up price and volume measures.

The supply and use tables provide the weighting structure needed for calculating national accounts at constant prices and, more generally, for drawing up consistent price and volume measures for national accounts aggregates. Indeed, without supply and use tables it is extremely difficult to implement the double deflation system in a consistent manner.

(5) Strong starting point for provisional yearly plus quarterly national accounts.

The structural relationships embedded in a set of supply and use tables are of great value for improving the reliability of provisional and quarterly accounts which frequently have to be based on indicators instead of solid statistical information in the form of observations of the *levels* of the variables.

Turning now to the limitations of the supply and use table framework, it should be realised that the approach basically consists in the systematic and intelligent use of all the available information. As already observed, the supply and use tables can be used to fill gaps in basic statistics, but only at the cost of weakening the cross-checks which are the main strength of the approach seen as an integration framework. Supply and use tables therefore cannot serve as a real substitute for the basic statistics underlying independent or largely independent estimates of GDP from the production, expenditure and income sides. Supply and use tables should be seen as a complementary check to the check on GDP implied by independent estimates of GDP from two or three sides, not a substitute for this basic validation.

That said, exploitation of the links between products and potential uses is a powerful tool. If products could be split into two mutually exclusive groups, namely products used for intermediate consumption and products used for final uses, GDP could in principle be calculated from the supply side, given imports, exports and purchases by non-market producers, merely from exploiting the knowledge about the technical nature of products. In reality, such a strong relationship does not exist. Even in the case of gross fixed capital formation, there is no one-to-one relationship. A case in point is parts for machinery and equipment which may be used both as intermediate consumption and gross fixed capital formation. Nevertheless, the fact remains that most products have predominant uses, and it is this fact which contributes to making supply and use tables such a powerful statistical tool.

6.1.4 Construction of supply and use tables

6.1.4.1 Architecture of a system of national accounts based on supply and use tables

The basic structure of a statistical system capable of producing supply and use tables consists of the following building blocks:

1. definition of the products to be specified in the supply and use tables in terms of product nomenclatures;
2. maintenance of an updated key between nomenclatures used in domestic production statistics and foreign trade statistics and the products (commodity balances) employed in the supply and use tables;
3. product statistics (breakdown of total output/sales by commodity) for most of the goods-producing industries (agriculture, manufacturing, energy, construction) and preferably also for services;
4. foreign trade statistics for goods and balance of payments records for exports and imports of services;
5. key between activities/industries and national accounts products for industries not covered by product statistics;
6. accounts statistics or administrative records giving the ratio of intermediate consumption to gross output for the various industries;
7. cost-structure surveys giving the breakdown of total intermediate consumption by product, and
8. sources giving final household consumption, gross fixed capital formation and changes in inventories by product groups.

In a supply and use table framework items (1) and (2) are indispensable, since the whole idea is to combine domestic production statistics and foreign trade statistics in order to determine the supply of each product available for domestic uses. Items (3)-(8) should ideally be available with comprehensive coverage each year. In practice, some of these points may only be covered partially and at intervals of some years. A supply and use table system is also workable in these circumstances by exploiting the benchmark information to estimate yearly figures.

Ideally, each producer unit in basic statistics should be double-coded by both sector and branch in order to ensure consistency between the tables by industry (supply and use tables) and the institutional sector accounts. This double coding is not necessary for the supply and use tables as such, but in situations where a new system of national accounts is established, it is advisable to take this step in order to anticipate the further development and integration of the full system of national accounts. The result of this is the sector-industry table recommended by the SNA.

6.1.4.2 Basic statistics required

The statistical unit used for the production and generation of income accounts of the SNA, and hence in supply and use tables, is the establishment (local kind-of-activity unit). Ideally, production statistics and cost-structure surveys should be available for industries defined as aggregations of establishments. In practice, the statistical unit in production statistics for some activities is likely to be the enterprise i.e. a larger and more heterogeneous unit than the establishment. A system of supply and use tables does not require production statistics drawn up from questionnaires filled out for establishments to be available for all industries. Statistics based on enterprise information will in most cases provide a reasonable approximation.

However, the strength of the system both as integration framework and for input-output analysis will be greater the more homogeneous the industries in the system. National accountants should therefore take care to separate out, wherever possible, trading and construction activity carried out as secondary activity in other industries and gather together trade and construction in "pure" branches which in principle encompass all trading and construction activity in the economy. Concentration on trade (merchanting) and construction is recommended because these secondary activities are likely to be quantitatively important and to have an input structure which differs greatly from those of the primary activities with which they are combined. Trade (merchanting) will be a secondary activity in many industries even when the statistical unit is the establishment.

6.1.4.3 Filling the gaps if some of the basic statistics are missing

If production statistics are missing, fiscal information may often serve as a reasonable substitute, provided it is adjusted for definitional differences and underreporting. The latter point should not be exaggerated, though. If enterprises underreport their turnover, say, on fiscal returns, chances are that they will do the same on statistical questionnaires. In both cases, corrections are needed for underreporting. Often cost structure surveys will be missing for a number of industries in the economy. In that case, the input structure will have to be estimated on the basis of the input structure of similar industries and/or common sense considerations.

Gaps on the expenditure side can generally be filled by calculating the residual: output + imports - intermediate consumption - exports. In that case, however, the autonomy of the expenditure estimates vis-à-vis the production side is lowered, and the value of the cross-checks in the system is correspondingly reduced. Nevertheless, one of the major strengths of a supply and use table framework is precisely the fact that rather detailed information can be derived for final demand components by exploiting the accounting identities of the system of national accounts in conjunction with product information. A case in point is gross fixed capital formation by type of product. If the relationship between type of product and category of use is strong, and if imports constitute a large part of total supply, estimates for GFCF derived using the product-flow method will, in fact, have a reasonable degree of autonomy.

6.1.4.4 Benchmark versus current years

If one has to build up a supply and use table framework from scratch, one of the greatest challenges is the establishment of the initial input structure and the initial structure of trade and transport margins. Drawing up these initial structures requires mobilising the maximum number of cost-structure surveys available plus surveys of final household consumption and gross fixed capital formation. In the total absence of information on certain parts of manufacturing and construction, which is the normally the area with the most complex input structure, it may be necessary to resort to (a) the input structure of neighbouring industries, (2) input structures from other countries with a similar economic structure, or (3) common sense considerations. For market service industries, the input structure in terms of broad categories of products may frequently be available in accounting statistics and reports from branch organisations. The detailed product breakdown must then be estimated on the basis of similar industries and common sense considerations.

For current years, it will normally be most efficient to begin with the input structures and the composition of final uses from the previous year at *constant prices* (Leontief assumption) and to modify the structure known from the past in the light of new cost-structure and final demand surveys that have become available in the meantime. In practice, this is done by inflating all the product flows in year t-1 by t/t-1 price indices and deriving the technical coefficients from the inflated year t-1 use table at basic prices. These technical coefficients are then used to distribute the totals of intermediate consumption and the totals of final demand components at basic prices by product. This inflation procedure implements the Leontief assumption by adjusting the technical coefficients from year t-1 for relative price changes between year t-1 and year t.

6.1.5 The balancing process

6.1.5.1 Drawing up the initial estimates to be balanced

The computation of the initial (unbalanced) estimates of supply and use tables to be balanced in current years involves the following 7 steps:

Step 1 Calculate the supply matrix S from domestic production and product statistics plus foreign trade statistics.

Step 2 For all industries, take total intermediate consumption by industry from the calculation of GDP(O). Take all final demand components, i.e. final household consumption by purpose, collective consumption by purpose, gross fixed capital formation by type, changes in inventories by type and exports, from the calculation of GDP(E). These data together give the column totals of matrix P.

Step 3 Move from the column totals of matrix P to the column totals of matrix B. This is done by using matrices T and V from year t-1, adjusted for changes in the tax rules and adjusted so as to be aligned with tax revenues on an accrual basis, to calculate the column totals of matrices T and V. The column totals of matrix (P-V-T) are then distributed between the column totals of matrices B, W, TR and R using the relationships between these column totals in year t-1, and preferably adjusted so as to match the target totals of trade and transport margins in the current year t.

Step 4 Vertical distribution at basic prices. The column totals of matrix B derived in step 3 are distributed by product (vertically) using the inflated technical coefficients from year t-1 as described in section 6.1.4.4.

Step 5 Horizontal distribution. The differences between the row totals of matrix S less exports and changes in inventories and the row totals of matrix B less exports and changes in inventories is distributed over uses (horizontally) by proportional distribution along the rows of matrix B except for the items exports and changes in inventories.

Step 6 Initial estimates of matrices W, TR and R. These matrices are constructed by multiplying the matrix B after step 5 by the coefficients (rates of trade and transport margins) implied by matrices W, TR and R from year t-1, and subsequently adjusting (proportionally) the resulting matrices to make them tally with total trade and transport margins as given by the row totals for the trade and transport industries in matrix S.

Step 7 Initial estimate of matrices T and V. These matrices are estimated by modifying the T and V matrices from step 3 in order to take account of the changes in product flows intervening in steps 4-6. The adjustments are made proportionally so as to respect the total tax revenue on an accrual basis.

Note that the supply table is not modified at this stage. The procedure is thus based on the assumption that, at the level of individual products, supply is determined with greater certainty than uses. The above description gives a somewhat simplified picture. In practice, parts of the use tables will be determined and balanced in advance in subsystems (satellite accounts), for instance energy and insurance services. Similarly, trade and transport margins on certain product groups may be constrained by total margins of particular branches of trade and transport industries. Furthermore, in practice steps 3-7 will be caried out several times in an iterative process. In practice, one starts by distributing the column totals in the matrix (P-V-T) according to the relationships between the column totals in B, W, TR, and R in year t-1 with a subsequent adjustment to the current year sum totals for trade margins.. Then steps 4-7 are exercised. After that one can return to step 3 and compute an improved split of the column totals in P into column totals of the matrices V, T, R, TR, W and B. Even so, the description contains the essence of the procedure required in order to manage a system of supply and use tables in practice.

The vertical and horizontal distributions set out in steps 4 and 5 above are essentially the first two steps in the well-known iterative procedure known as RAS which is used for automatic updating of symmetric input-output tables. It should be observed that the RAS procedure cannot, however, balance a set of supply and use tables. The reason is that the necessary condition that the sum of column totals equals the sum of row totals is not satisfied. Taking automatic balancing further than the first two steps of RAS requires an algorithm which is considerably more sophisticated. Anyway, before considering the elimination of minor differences by automatic procedures, it will usually be necessary to treat a large number of substantial differences manually.

After step 7, all product balances are equilibrated. Supply equals use. GDP(O) equals GDP(E). In that sense the above procedure has already balanced the national accounts. However, the column totals in these initial use tables differ from the initial estimates of the column totals implied by the initial estimates of GDP(O) and GDP(E). The balancing process consists primarily in changing the uses of products in such a way as to strike the best possible compromise between the column totals of intermediate consumption by industry from the GDP(O) estimate and the column totals for categories of final uses from the GDP(E) estimate. Moreover, to the extent that initially estimated supply of a given product or groups of products differs from demand in cases where demand information is very reliable, the supply matrix will also have to be reconsidered. In most cases, though, the supply matrix is not modified at any point in the balancing process.

6.1.5.2 Keeping track of uses at different price levels

The balancing process requires software which enables several national accountants ("arbitrators") chosen to settle the dispute between the initial estimates of the components of GDP(O) and GDP(E)) to work on the initially established supply and use tables simultaneously. Each arbitrator enters changes to these initial tables in a separate *amendments file* at *basic* prices, which is the price level at which supply and use must balance for individual products. Given the changes at basic prices, the computer system automatically computes the consequences for wholesale margins, transport margins, retail margins, taxes less subsidies on products and VAT by applying the relevant percentages from the initial files. Moreover, it is possible to introduce changes to all value levels in the supply and use tables. In particular, it is possible to amend the individual cells for trade margins and taxes on products manually during the balancing process. In addition, it is possible to introduce amendments at the level of purchasers' prices and let the software compute backwards from there. However, in the latter case the arbitrator has to make subsequent adjustments in order to ensure that the product balance continues to have resources equal to uses at basic prices.

When all the arbitrators have finished their work on the areas of the economy for which they are responsible, there will still be some generally minor differences between the total use of trade and transport margins and the corresponding supply. A final round of balancing ensures that trade and transport margins plus taxes in the use table sum up to their target totals on the supply side. Throughout the process, updated macro control tables showing the consequences of the amendments introduced for the national accounts aggregates as well as the distance from the original column totals of the supply and use tables are available to the arbitrators. The balancing process is terminated when the results shown by these control tables are found to reflect the best possible compromise between the initial (inconsistent) estimates.

6.1.6 From supply and use tables to symmetric input-output tables

6.1.6.1 Technology assumptions

Symmetric input-output tables are analytical tables used for input-output analyses. Contrary to supply and use tables, which in principle are observable, they are based on certain assumptions. The format of symmetric input-output tables is either product x product or industry x industry. Product by product tables show the inputs of products into production of products and final uses, whereas industry by industry tables show the inputs of deliveries from industries into the production of output of industries and final uses. In both cases the conversion from the statistical supply and use tables to the analytical symmetric input-output tables requires certain assumptions. The use of assumptions is necessitated by the presence of secondary production. If there were a one-to-one correspondence between industries and products, the symmetric input-output tables could be derived from the supply and use tables by simple aggregation. The two standard technology assumptions are the so-called product technology assumption and the industry technology assumption. In constructing symmetric input-output tables, it is possible to combine these two models into a mixed-technology assumption.

Whereas the literature on supply and use tables is sparse, there is a vast literature on the construction of symmetric input-output tables. This is probably due to the fact that the latter topic has been seen as the more interesting by theoretical economists. The size of the literature on the two issues should not be seen as a reflection of their relative importance. In practice, it is much more important for the quality of symmetric input-output tables to get the supply and use tables right and to have a reasonably detailed description of the economy than to use one or the other set of technology assumptions for the conversion from supply and use tables into symmetric input-output tables.

6.1.6.2 The treatment of imports

Given that the supply table specifies the share of each product which is imported, the application of technology assumptions in the conversion from the supply and use tables into symmetric input-output tables automatically gives total imports into each of the columns of the symmetric input-output tables. It is not necessary to aggregate imports by product into one single line, though. In the product x product tables, the Leontief matrix A, which shows the input of products into the output of products, can be compiled for both domestic production and for imports. The same is true for industry x industry tables. Such detailed information on imports is valuable in many analytical uses of input-output tables. Consequently, compressing the detailed information on imports available in the supply and use tables into a single line when drawing up the symmetric input-output tables is not to be recommended.

6.2 Other methods of validating the GDP estimate

In addition to all the cross-checks involved in the balancing of the initial estimates of GDP from all three sides, both the balanced GDP value and the components of the output, income and expenditure sides undergo various further checks and validation procedures, the most important of which are:

1) probability checks on changes at constant prices (real growth rates);
2) comparison of theoretical and actual VAT receipts;
3) comparison of sectoral accounts for the household sector and tax statistics;
4) comparison of lending/borrowing in the non-financial sector accounts and lending/borrowing in the financial sector accounts prior to the final balancing, and
5) employment comparisons.

1) gives rise to further balancing corrections in many cases. During the balancing process described in Section 6.1, the statisticians involved constantly keep an eye on the implicit real growth rates. If these seem *a priori* to be improbable, the initial estimates of output, intermediate consumption and the final expenditure components are re-examined and balancing corrections may be made. As a result of this feedback from deflation to balancing in current prices, there may to some extent be said to be an integrated balancing of the estimates at current and constant prices. But the supply and use matrices are deflated at a later stage than the current-price balancing. In exceptional cases, problems at this level of detail, which do not come to light until the deflation, give rise to a rebalancing of the supply and use matrices at current prices. One of the checks on changes at fixed prices is a probability check on productivity changes, i.e. changes in real value added per person in employment.

2) was discussed in Section 3.25.3.

3) consists of a comparison of the gross income in the household sector with personal gross income according to tax statistics after correction for conceptual differences

4) was discussed in Section 1.6.3.

5) is discussed in Section 7.3

The final result of the GDP balancing for 1995 can be seen in Table 130.

Table 130 Initial estimates for GDP, three approaches plus balanced value

	DKK million	% of GDP
Output-based GDP - GDP(O)	1 009 179	99.9
Income-based GDP - GDP(I)	1 009 562	100.0
Expenditure-based GDP – GDP(E)	1 013 897	100.4
Balanced GDP	1 009 756	100.0

For 1995, the initial estimates of GDP based on the production and income approaches are similar, the discrepancy being under 0.1%. The initial expenditure-based estimate is somewhat higher, but all three measures are still within a range of 0.5% of GDP, i.e. the normal range. The final balanced value is closest to the initial output- and income-based estimates, which is logical given the greater statistical weight attached to two initial estimates than to one. This final balanced level reflects the best possible compromise between the three initial estimates for 1995 in the light of the detailed information on the kind and possible uses of the individual products in the economy, which is incorporated into the supply and use tables.

The total difference between final uses and the initial estimates as a result of the balancing is –DKK 4.1 billion. This is divided into –DKK 3.8 billion for household final consumption, –DKK 1.3 billion for gross fixed capital formation and - DKK 1.0 billion for changes in inventories. Government consumption expenditure and exports and imports are unchanged from the initial estimates.

The above initial differences between the original estimates obtained from the three possible approaches are specific to 1995 and cannot be said to reflect any general pattern. For other years, the differences may have the opposite mathematical signs.