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## **THE SUPPLY AND USE TABLES IN THE DANISH NATIONAL ACCOUNTS**

Invited paper submitted by Statistics Denmark\*

### **I. INTRODUCTION**

1. The current Danish system of Supply and Use Tables (SUT) was established in the mid-seventies. Since then the calculation of annual SUT's has been totally integrated in the compilation of annual National Accounts in both current and constant prices.

2. The integration of SUT in the compilation of National Accounts implies that a number of NA aggregates are derived directly from the SUT. This particularly relates to all the NA aggregates in the "Goods and services account" and the "production account". The integrated procedure is in contrast to a procedure, where SUT are compiled after the production of the NA figures, implying a number of restrictions on the totals of the SUT.

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3. In general terms, the advantage of compiling SUT as an integral part of the production of national accounts can be formulated as follows:

- It is the most efficient way to incorporate all basic data – aggregated or detailed – into the national accounts framework in a systematic way.
- It is an effective way to ensure consistency at a detailed level and thereby improve the overall quality of the national accounts.

4. The Danish SUT are compiled in connection with the final annual accounts, which are released with a delay of almost three years. The structural information entailed in the SUT for the latest final year is used in compiling the preliminary annual and quarterly national accounts but no balanced preliminary or quarterly SUT are produced. The following description therefore refers to the compilation of the SUT as a part of the final annual national accounts. The description only covers the calculations in current prices. Although, complete SUT at constant prices are also produced these are not described in this paper.

## **II. THE FRAMEWORK OF SUPPLY AND USE TABLES IN DENMARK**

5. The principle of the Danish SUT-system is illustrated in figure 1. It shows the supply and use of all products and the treatment of the connection between the different value levels (basic values, purchasers' values). The submatrices for basic values, trade and transport margins, net taxes on products, non-deductible VAT and purchasers' values are stacked as "layers" to visualise the transformation from basic to purchasers' prices for each cell of the system.

6. Products are shown as rows, categories of use (by industries, consumption groups etc. when relevant) are shown as columns. Please note that what is here referred to as rows and columns consist of the relevant parts of all the "layers" shown in the figure.

7. As a starting point, supply is shown as a matrix of basic values on the left side of the figure. On the right side of the figure the use matrix at basic prices is shown as the bottom "layer". In the balanced commodity flow system total supply at basic prices must equal total uses at basic prices for each product. Trade and transport margins are here a special case: On the supply side they are shown as output of trade services at basic prices from the industries in which they are produced, but they are left out from the basic price level on the uses side. Here, they are shown in the margin matrices where they are distributed, together with the basic values to which they are related. The wholesale trade matrix also includes transport margins.

8. Net taxes on products and non-deductible value added tax are also distributed as matrices on the uses side.

9. In the rows and the columns there are distinguished between the following groups:

- There are approximately 2750 products, which consist of approximately 2300 goods and 450 services. For goods the categories are defined as one or more 6-digit Harmonized System groups. There is at least one NA-good for each 4-digit HS-group. A key linking the NA-goods to CPA has been established. For services the categories are in principle based on 4-digit CPA. In some areas, 4-digit CPA groups have been subdivided (e.g. in the area of business services) in others a number of 4-digit CPA groups have been aggregated to the NA-categories (e.g. trade) The NA-categories for services are kept almost constant for a number of years. The key defining the NA-categories for goods is updated annually in order to take account of - normally relatively few - changes in the HS-groups.
- The number of columns for domestic production is 130 reflecting that a distinction is made between 130 activity groups. Those groups are based on the official Danish nomenclature of economic activities, which have direct links to NACE and ISIC. The classification by activity is based on establishment units (Kind-of-activity units). In a few cases it has been found important to have more homogeneous industries than allowed by the existing statistical units. This applies to agricultural production, construction, trade and motor vehicle repair. Thus for example, all trading activity is combined into the activity-defined trade-industries, regardless of the industry in which the unit performing the activity is classified in the primary statistics.
- The import column is a vector showing imports by products. At a later stage it is expanded into a matrix including a geographical dimension, but this is not a part of the core SUT-framework.
- The intermediate consumption is broken down by the same 130 activity groups as domestic production. For the moment there is one extra industry showing the intermediate consumption of FISIM.
- Final consumption expenditure of households is subdivided into 72 groups. The classification is based on COICOP. Final consumption expenditure of NPISH forms a separate group.
- Final consumption expenditure of general government is divided into three major groupings, collective consumption expenditure, individual consumption expenditure on services produced by general government and individual consumption expenditure on services produced by market producers but paid by general government and supplied to households - without any transformation – as social transfers in kind. Each one of these groups is further subdivided according to main purpose (according to COFOG) to form a total of 29 groups.

- Gross fixed capital formation is subdivided into ten groups according to type of investment good (transport equipment, new buildings etc.). Together with the product rows this leads to a diagonal structure with only few off-diagonal elements. The justification for this subdivision is due to practical aspects of our systems for preliminary and quarterly accounts.
- Changes in inventories are classified into 6 groups depending on the kind of stocks (for example, stocks of raw materials, stocks in wholesale trade etc.)
- The export column is a vector showing exports by products. At a later stage it is expanded into a matrix including a geographical dimension, but this is not a part of the core SUT-framework.

### III. OVERVIEW OF THE BALANCING PROCESS

10. The compilation of the SUT for a given year contains the following steps:
  - The first step is to incorporate all the available data on the actual year to target totals and other values that can be entered directly into the system as predetermined.
  - The next step is to create an initial version of the SUT. This version is compiled using automatic processes, but at this stage a number of unsolved problems will remain: For some products supply is not equal to uses. For most categories of use the totals will usually differ from their targets. Total trade and transport margins and total VAT may also differ from their respective targets. This step will be referred to as "Automatic balancing".
  - Then follows a step, where the initial version of the product balances is adjusted manually. The unsolved problems are examined closely. In many cases such problems will reveal errors in the calculations producing data input to the product balances or in the primary statistical data. Solutions to such problems may be found in co-operation with the relevant sections of the statistical bureau and may involve changes in supply, predetermined uses or target totals. A number of products are redistributed between uses to bring the distance between totals and targets within an acceptable range for each category of use. Corrections to the initial balances are entered into the system to create a new - but not yet final - version. This step will be referred to as "Manual balancing"
  - In the last step the differences between totals and targets are removed except where such differences are considered acceptable. In this step trade and transport margins and VAT are adjusted to their targets. This step will be referred to as "Final balancing".

#### IV. INCORPORATION OF AVAILABLE DATA ON THE ACTUAL YEAR

11. In a number of subsystems all available data are adjusted or transformed before they are incorporated into the SUT-framework. The available data for a given year is never complete in the sense that it makes it possible to fill in all the elements of the supply and use tables. However, it offers – as briefly described below – a sufficiently restrictive frame for the values in the system in order to fill out the complete SUT in a reliable way.

12. The available data differs, of course, across countries and in a given country over time. However, the ongoing harmonisation between EU-countries ensures that very important data sources for constructing SUT will be available in those countries. This applies in particular to the Structural Business Statistics (including accounting statistics for almost all industries), the Prodcom statistics (output in manufacturing by industry and product), foreign trade statistics and agricultural statistics.

13. In the annex there is a short general description of which data is currently incorporated in the annual SUT-framework. The description covers data that are considered to be reliable enough to be classified as predetermined. This means that it will not be changed in the process of automatic balancing, but can only be changed later in the manual balancing process. It reflects, of course, the specific data situation in Denmark, but it might, after all, be of interest to other countries as well. It follows from these considerations that there are other kinds of information – usually less reliable – that are used in the SUT-framework. This is described in the section on automatic balancing.

14. These initial calculations result in coverage of the following parts of the SUT-framework, cf. figure 1:

- A complete supply matrix
- Target column totals for all uses at purchasers' values
- Distribution on the use side by products of the columns for exports and changes in inventories at purchasers' values and of the columns for final consumption expenditure of general government at all value levels.
- Full specification for certain products (rows) at all value levels on the use side.
- Specification of certain cells or groups of cells on the use side.
- Total value of net taxes on products by product (Row totals for the matrix "Taxes on products").
- Grand total for the VAT-matrix.

15. Furthermore, the logic of the framework offers the following general information:

- Target totals for use of each product at basic values (row totals for the use part of the basic value matrix) being identical to the total supply of the product. Although this is a simple feature of the system it is probably the most important feature and highly useful in ensuring the overall quality of the national accounts.
- Grand total for the wholesale trade matrix being equal to the part of output of the wholesale trade that is distributed as margins.
- Grand total for the retail trade matrix being equal to the output of the retail trade.

## V. AUTOMATIC BALANCING PROCEDURES

16. It is important to understand that the automatic balancing procedures do not result in fully balanced SUT-tables. The automatic procedures contain two steps, a column adjustment followed by a row adjustment. This, on the one hand, results in unbalanced SUT's where the remaining problems can be managed in a reasonable way, and on the other hand, makes it possible to trace manually the changes of the values in the system.

### Starting point

17. The data described in the previous section are directly incorporated in the SUT-framework. It is as mentioned treated as predetermined values which means that it will not be changed in the process of automatic balancing, but can only be changed later in the manual balancing process.

18. Before any balancing or distributive procedures can begin there have to be some plausible figures in all relevant cells on the use side. A standard default solution – for non-predetermined values - is here to use inflated values and relations from the balanced SUT of the preceding year. In the absence of better knowledge it is initially assumed that product structures in the columns at basic values and corrected for price movements are constant. This is tantamount to assuming that the product structure in a given column at constant prices is unchanged. Furthermore, it is assumed that trade margin percentages, percentages of taxes on products and VAT are constant over time or at least are moving in the same direction in a proportional way.

19. However, there are a number of cases where there is better information about the product structure on the uses side than the standard information from updated structures of the previous year. This kind of information is not considered reliable enough or suitable to enter directly as predetermined values but still to have informative value.

20. To ensure the overall quality of the system it is of great importance that – at least occasionally – data on the use of raw materials in manufacturing and detailed information from household's budget surveys are incorporated. Whenever these data are available they replace the default data on structures of the previous year.
21. Another example of this kind of data is gross fixed capital formation where the system described in the annex also offers an initial estimate of the product structure for those cells, which are not predetermined. A third example is corrections to the matrices on taxes on products and VAT in order to take account of changes in tax rates and systems.
22. In this way, additional information from numerous ad hoc investigations has over the years been incorporated in the SUT-framework. This concerns, for example, investigations by the Anti Trust Authorities on the cost structure in particular industries, investigations by Statistics Denmark on building cost structure in relation to a new index for building costs, output of advertising services distributed by customers etc. The list is very long.
23. As mentioned above, all these kinds of data replace the default information from updated structures of the previous year. As they are not deemed predetermined they will be changed during the automatic balancing procedures described below.

#### Column adjustments. "Vertical distribution"

24. The procedures described in the previous section gives a starting point for the automatic balancing procedures. The matrices will at this point be unbalanced in the sense that total use is not equal to total supply at basic values for most products, and the sum of the values in a given column is not equal to the calculated target column totals.
25. A first step towards a balanced system is to adjust the values in the columns, so they add up to the target column totals. For most uses targets exist only for totals at purchasers' values, but for some columns targets may exist for other levels as well. Trade margins used in certain consumption groups can be an example.
26. The adjustments are made simultaneously at all price levels without changing any predetermined values. To adjust the values in a column, all non-predetermined purchasers' values are multiplied by:

$$\begin{aligned} & \text{(target column total - sum of predetermined values)} \\ & \text{divided by} \\ & \text{(sum of starting values - sum of predetermined values)}. \end{aligned}$$

27. In a simple case, with a target for purchasers' values only, the same correction factor is used for non-predetermined values in all levels. If targets exist for other levels, the situation is somewhat more complex and there is a need for general corrections to trade margin percentages and/or tax-percentages used in the column. All these problems are solved automatically.

28. Some restrictions are put on the automatic adjustments to avoid creating unrealistic values. Automatic changes of sign are not allowed. The appearance of negative basic and purchasers' values are restricted to certain products that may be negative private consumption or disinvestments (examples: scrap, ships, cars) and uses (example: changes in inventories) unless the negative values are entered as predetermined. When both positive and negative uses are present in the same column the results of proportional adjustments can be unpredictable. In such cases all negative uses are entered as predetermined values. The programming ensures that warnings are issued when problems of this kind are encountered.

29. It follows that automatic adjustment will in certain cases fail to equal column totals to targets. In these cases the columns are written to a list of unsolved problems.

30. After "vertical balancing" we have a set of columns that (with the exception of the problematic columns mentioned above) represent an initial breakdown of the target value for purchasers' values into products using the initial assumptions about product structure from the starting values. Since all levels are adjusted simultaneously we have also a breakdown of all purchasers' values into the levels from basic prices to VAT.

31. Total use at basic values of each product will only equal supply in special cases as a result of predetermined values or by pure coincidence. Likewise, the sum of the values in the other value levels will usually differ from their target values.

#### Row adjustments. "Horizontal distribution"

32. The next step towards a balanced system is an adjustment of the values in the rows on the use side to the target totals in the rows.

33. The procedure starts by adjusting the level of basic values, and the adjustments are again made without changing the predetermined values. These include basic values in cells with predetermined purchasers' values to avoid either distortion to trade margin percentages or changes to the original predetermined purchasers' values of these cells. All the non-predetermined basic values in a row (product) are multiplied by

$$\begin{aligned} & \text{(supply at basic prices - sum of predetermined values)} \\ & \text{divided by} \\ & \text{(sum of basic values from the "vertical distr." - sum of predetermined values)} \end{aligned}$$

34. In these uses non-predetermined margins and taxes on products are changed by the same factor.

35. In the matrix for net taxes on products the non-predetermined values are then adjusted to the target row totals and finally the non-deductible VAT is recalculated to reflect the adjustments in the other levels.

36. Similar to the vertical balancing procedure the computer-program is able to trap adjustments that would lead to unrealistic values. For the same reasons as mentioned above



the automatic balancing will fail to equal supply and use for a number of products. Typically, supply is insufficient to cover the predetermined uses of the product. The rows that are left unbalanced in one or more levels are - like the unbalanced columns - written to a list of unsolved problems.

37. The use table that is the result of the horizontal balancing procedure will (except for the unbalanced products mentioned above) fulfil the requirement that for every product total use must equal total supply at basic values and that net taxes on products should equal their target row totals.

38. However, the sum of the values in a given column will usually differ from the target column total. Furthermore, the sum of all trade and transport margins on the uses side will be different from the output of the trade industries and the sum of VAT will differ from the calculated total.

#### Automatic balancing as a repeated process.

39. For illustrative purposes the description of vertical and horizontal balancing has here treated the automatic balancing as two separate processes. In reality the whole procedure is handled by a single job that uses a few minutes on a modern PC (with a master file of approximately 50,000 records. Preparation of the data-inputs for the process is far more time-consuming). Every time the job is run, new listings of unsolved problems and resulting totals are produced.

40. When run for the first time with data for a new year a number of serious problems in the data-inputs will usually be revealed. Often problems can be traced back to errors and inconsistencies in data from the statistical sources. Some of these will need to be corrected because they will otherwise cause major distortions in the initial balances.

41. Before the system is ready for manual balancing the totals of trade and transport margins and non-deductible VAT should be brought within acceptable distance from their respective targets. Adjustments to total trade and transport margins are done by proportional adjustments to all trade margin percentages of the starting file before the vertical/horizontal balancing except in cells with predetermined trade and transport margins. If total VAT cannot be brought within acceptable limits by small adjustments to rates and assumptions used in the calculations, VAT may be left unbalanced at this stage. A search for a specific explanation of the difference may be more appropriate in this case.

42. In principle, the vertical-horizontal balancing procedure could be repeated in an iterative manner, where each iteration would use the result from the preceding as a starting point. This could, however, be a dangerous method at this early stage, where many problems are unsolved, and are therefore not used. Automatic balancing as a repeated procedure should therefore not be mixed up with the iterative RAS-procedure.

## V. MANUAL BALANCING

43. The unbalanced SUT resulting from the automatic balancing procedures is now transferred to the process of manual balancing. This task is conducted by 4 to 6 persons (balancers) within a month. Each person is responsible for an area of the economy. Such areas consist of a complex of industries and categories of final use with a high degree of interaction and their common products on either the uses- or production side. On the other hand, all products and categories of use must belong to a complex to ensure that they all are monitored by a responsible person.

44. The tasks of each balancer are the following:

- Eliminate still existing differences between supply and use of products at basic prices. These differences may be due to various explanations. As mentioned earlier, serious problems may reveal a need to correct data from primary statistics. However, many remaining differences may be explained by differences in the coding of the same kind of products between production- and foreign trade statistics, and the problem can then be solved by moving output, imports or exports from one product to another.
- To check the credibility of the results from the automatic balancing.
- To redistribute products between uses until the sum of values in a column are inside an acceptable distance from their targets.
- To evaluate whether the results indicate needs for adjustment of the target column totals. The different target values will usually not be equally well founded on statistical sources. The less well-founded target column totals might be reconsidered in the light of the additional information obtained from the SUT-framework.

45. To keep the system manageable certain rules are to be followed. One of these is that all products are kept balanced with total uses = supply during the balancing process. This also applies to net taxes on products other than VAT. Another is that even though balancers are allowed to make corrections outside their "own" area, they have to ensure that major changes outside one's own complex are always negotiated with the "owners" of the other complexes involved, and that information is passed between the relevant persons.

46. Yet another important aspect of the manual balancing procedures is the need for documentation. Many corrections entered by the "balancers" will be independently motivated with references to statistical and other available sources or with common-sense considerations. It is important that the considerations behind the solutions are visible to other "balancers" and that the solutions can be reproduced, when the same problems are encountered in following years. These comments are entered directly in the spreadsheets where the adjustments are made.

47. The "balancers" use spreadsheets as an interface to a shared master file containing the SUT-tables. Procedures for extracting data from master-file to spreadsheet and transferring corrections from spreadsheet to the updated master-file are available as macros in the spreadsheet- environment.

48. When updating the shared master-file it is important that no invalid data are allowed as corrections. All corrections are tested for errors before they are accepted. Corrections to the cells need not necessarily be specified by the "balancers" for all levels from basic values to purchasers' values. The program that is used to update the master-file carries out the calculation of the missing values from default assumptions. As default the original trade margin percentages from the master-file are used, and VAT is recalculated using the updated values.

49. In the process the "balancers" always have access to updated information on the state of the system like remaining differences between supply and uses at basic prices by product and the actual distances between column totals and their targets. Also this information is obtained via macros in the spreadsheet. It is also possible to extract information from the master-files of previous years for comparison purposes.

## **V. FINAL BALANCING**

50. When all manual corrections have been made, the sum of values in a given column will only differ marginally (if at all) from the – eventually adjusted - target column totals. Furthermore, there will be small differences between the sum of the margin matrices and their target values and a corresponding difference for VAT.

51. The first step in the final balancing procedures is to adjust the trade matrices to their targets by proportional adjustments of non-predetermined margins and recalculate VAT based on the adjusted values.

52. This will result in new – but still small – differences between the sum of values in a given column and the corresponding target column totals. The target column totals are now divided into two groups: Those that are binding and those where small deviations can be accepted. This division, of course, reflects to a large degree the statistical sources and the reliability thereof. In our case the target totals, where small deviations can be accepted, are usually to be found for a number of groups of private consumption expenditure, certain groups of gross fixed capital formation and a few groups of intermediate consumption.

53. The second step in the final balancing is then to distribute the differences between the sum of column values and their binding targets. The cells that can be involved in these corrections without causing inconsistencies in the system are isolated. The corrections are made at the basic values and create new (small) differences between supply and uses for many products.

54. These differences are removed in the third step by a new horizontal distribution among the uses without binding targets. In this process trade and transport margins are not allowed to change and changes to margin percentages should be kept to a minimum. If these calculations should result in significant distortions the program issues warnings. Some manual adjustments may still be needed in cases where small values can be moved without creating significant distortions.

55. The total of non-deductible VAT that is a result of the balancing procedure cannot be expected to exactly match the target that is based on government accounts. It may be preferred to proportionally adjust VAT in specific columns, where the exact share of VAT-liable use is uncertain. A final proportional adjustment of VAT on all private consumption is used to eliminate the remaining difference.

## **VI. CONCLUSION**

56. As mentioned in the beginning of this paper our SUT-system in connection with the annual final accounts has been working for almost 30 years. During those years new developments have taken place but the basic principles of the system are unchanged. And we still have a lot of ideas for improvements that are included into the system on a current basis. However we have no plans for fundamental changes.

57. An area that has changed considerably is the EDP-tools available. Major efforts have over the years been made in order to develop programs and software applicable to the system. And at the other hand, many of the improvements have only been possible due to the development of EDP-tools.

58. The calculation of the final annual national accounts in current prices as described in this paper – including the preparation of available data – involves approximately 5 man-years on an annual basis.

## ANNEX

1. In this annex a short general description is given of the data that on an annual basis are incorporated directly into the SUT-framework.
2. On the supply side (cf. fig. 1) the available data make it possible to fill in the complete supply matrix annually. Data from the agricultural accounts, accounting statistics (from the Structural Business Statistics) and the General government accounts makes it possible to calculate total output in basic values (column totals for industries in fig.1) for almost all industries. Only for a few industries (financial intermediation) separate calculations have to be made.
3. The breakdown of the total output of industries by products is for agriculture and general government derived directly from the primary statistics. For manufacturing the output totals are combined with the Prodcom statistics to calculate the product distribution. Information on the product distribution in the service area is scarcer. For some service industries there exist annual information on the output by products, for example transport and part of IT-industries. For others, we have to rely on older ad hoc information on the product composition. In some cases, where it seems reasonable and no other information is available, it is assumed that there is an equality between output of a given service industry and the characteristic product. For example, it is assumed that the output of architects consists of architectural services and the output of hairdressers consists of hairdressing. When this assumption is used it is done at the most detailed industry level (in total 800 industries).
4. Import by product is directly available from the foreign trade (goods) and balance of payments (services) statistics.
5. On the use side there is less abundant information, usually only for column totals. Except for final consumption expenditure of general government, exports and change in inventories we have only scattered and frequently irregular information about the use in a given category distributed by products.
6. For intermediate consumption by industry the total values in purchasers' prices are extracted from the same sources used for the calculation of total output.
7. The totals at purchasers' values for each of the 72 groups of final consumption expenditure of households are estimated using a variety of sources, most important information on the value of retail turnover to households and the household budget surveys. Data on final consumption expenditure of general government are available directly from the statistics on general government accounts, both for the 29 totals and distributed by products.
8. The subsystem for the estimation of the totals at purchasers' values for the ten different groups of gross fixed capital formation is rather comprehensive. The accounting statistics, together with information on newly established firms, give us for each industry a grand total for gross fixed capital formation. Together with information on the total domestic

supply of some investment goods (transport equipment, construction, breeding stocks and others) the totals at purchasers' values for each of the ten groups can be estimated.

9. Changes in inventories pose a special problem, first of all because it would be nonsense to assume a distribution by products proportional to the preceding year. Secondly a residual calculation of the change in inventories of each product using the definition that supply equals demand at basic prices is refused in part because it is possible to make more reliable estimates, but most importantly, because this would eliminate the use of the identity between supply and use as a tool for evaluating all the other estimates.

10. In some cases data on stocks of specific products are available, notably agricultural and energy products, but the usual data input is information on opening and closing stocks by industries. These stocks are then distributed by products on the basis of certain assumptions: For example, the stocks of raw materials in a given industry will be distributed on goods proportional to the intermediate consumption of goods in that industry. Stocks in a given trade industry will be distributed on goods proportional to the supply of goods typically traded in that trade industry. The changes in stocks are then calculated for each product using the usual price-correction technique. The result is a column for changes in inventories distributed by products (at purchasers' values) that can be attached a reasonable amount of plausibility.

11. Export by products (at purchasers' values) is directly available from the foreign trade (goods) and balance of payments (services) statistics.

12. Most column totals will be calculated at the level of purchasers' values. There are, however, some subsystems that calculate column totals for other value levels as well. For example, calculations for the column total of retail trade margins for some consumption groups are made. This implies that for those groups we have column totals for two (or more) value levels.

13. On the use side we have also some subsystems that annually determine parts of the use matrices. For example, we have subsystems for repair and maintenance of buildings and other construction and a subsystem for energy products. These subsystems determine the complete rows for these products on the use side at all value levels.

14. Other subsystems determine individual cells or a number of cells on the use side. This includes gross fixed capital formation in construction, ships and airplanes and a few other areas. For a given year there might be ad hoc information in certain areas that is considered suitable enough in order to enter as predetermined.

15. Furthermore, we have subsystems that in connection with the statistics on general government calculate the total (accrued) net taxes on each product (row totals in the matrix taxes on products) and the grand total of the (accrued) non-deductible VAT.

Figure 1

