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IMPLEMENTING THE REVISED SNA: RECOMMENDATIONS ON PRICE AND VOLUME MEASURES

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The 1993 SNA recommends chain volume indices over traditional fixed base indices as the principal measure of year-to-year volume movements in economic aggregates. Recognising, however, that "additive consistency" is important to many users, the SNA recommends that countries continue to compile traditional constant price data alongside the chain indices. In addition, the new international guidelines suggest a supply-use table framework for deriving indices. This paper considers how these demands can be met in practice. Particular attention is paid to deriving chain indices for industry value added within the same framework as that used for final demand components.

1. INTRODUCTION

One of the major changes in the 1993 SNA in the area of measurement of volume and price changes is the choice of chain volume indices over fixed base Laspeyres indices as the principal measure of year-to-year volume movements in economic aggregates. The recommendation to apply the chaining method is in line with the conclusions of the economic theory of index numbers, cf. Diewert (1987). Recognising, however, that "additive consistency," i.e. the property that accounting identities which hold for values at current prices also apply to the values in real terms, is essential for a number of important uses of national accounts data, the new SNA actually ends up recommending that countries compile two sets of volume measures, namely chain indices on the one hand, and series of indices covering periods of 5–10 years with a fixed base year on the other.

Another distinctive feature of the revised SNA is that it emphasises even more clearly than the old version that an integrated set of price and volume indices is possible only in an accounting framework such as that provided by the supply and use tables. Only by departing from a fully articulated commodity-flow system is it possible to ensure that the price and volume indices derived for the various components of GDP are consistent in the sense that the value concepts are coherent on the supply side and the uses side and that the weights used for deriving the indices are consistent, being derived from the same comprehensive accounting framework.

The recommendations of the new SNA are thus rather demanding. Not only is it required that the time series of price and volume measures should be derived from a time series of supply and use tables, but also that the compilation system should be able to generate both traditional constant price data with a base year which is changed every five or ten years and long series of chain indices.

The present paper considers how these demands can be met in practice, and in particular the continuity and aggregation problems encounted. Experience drawn from current work on implementing the new SNA recommendations to the Danish national accounts database, which has always been based on the commodity-flow approach, is used to illustrate the various complications and choices involved. Particular attention is paid to deriving chain indices for industry value added within the same framework as that used for final demand components. The results presented in this paper are preliminary and will be subject to further checks and investigations before a decision will be taken as to what time-series of volume and price measures to use for publication purposes in the future.

On the issue of the choice of index number formula for the chain volume index, the new SNA recommends the Fisher index, leaving open the option of using a Laspeyres chain index as an acceptable approximation. This conclusion, too, is in line with the findings of theoretical research in index number theory, cf. Triplett (1992). The present paper features these two sets of calculations on data drawn from the most detailed national accounts database covering the years 1966–90. The comparison of these two sets of volume indices shows whether the Laspeyres chain index yields a sufficiently good approximation of the Fisher chain index. The reason the time series is only extended to 1990 is that the accounts after this year are only available at a higher level of aggregation and so are not fully comparable to the earlier years as far as sensitivity to the choice of volume measure is concerned.

2. An Integrated Set of Volume and Price Indices

The supply and use tables needed to compile an integrated set of volume and price indices consist of:

- an $(n \times m+1)$ supply matrix showing supply at basic prices of n products by m domestic industries and supply at c.i.f. prices from the Rest of the World (imports);
- an $(n \times m+q)$ use matrix showing the use at basic prices of n products as intermediate consumption of m industries and as final use in each of q categories of final demand;
- an $(n \times m+q)$ use matrix showing the use of wholesale trade margins on n products as intermediate consumption of m industries and as final use in each of q categories of final demand;
- an $(n \times m+q)$ use matrix showing the use of retail trade margins on n products as intermediate consumption of m industries and as final use in each of q categories of final demand;
- an $(n \times m+q)$ use matrix showing the use of transport margins on n products as intermediate consumption of m industries and as final use in each of q categories of final demand;
- an $(n \times m+q)$ use matrix showing the use of taxes less subsidies on products on n products as intermediate consumption of m industries and as final use in each of q categories of final demand;
- an $(n \times m+q)$ use matrix at purchasers' prices equal to the sum of the above five use matrices.

It should be noted that the $1 \times m$ vector of "other" (non-product-linked) taxes less subsidies on production is not included in the above list. This is because such taxes cannot always be deflated in a meaningful way and they are not needed in order to calculate industry value added at basic prices, which in the 1993 SNA is the value added concept adopted.

This set of supply and use tables establishes the connection between supply, which is valued at basic prices, and uses which are valued at purchasers' prices including non-deductible VAT. In the application of this system to the Danish national accounts, the matrix of transport margins is merged with the matrix of wholesale trade margins, reflecting a convention to channel all transport margins on intermediate consumption via the wholesale trade industry. Moreover, until 1986, for simplicity non-deductible VAT was shown only as a $1 \times (m+q)$ vector, i.e. without the product dimension explicitly shown. Since then, a full $n \times (m+q)$ VAT matrix has been drawn up each year. One of the advantages of compiling the full VAT matrix is that it allows a check of actual vs. theoretical VAT receipts to be performed throughout the compilation and balancing process. This check is valuable as an indicator of the degree of coverage of economic activity in the accounts as well as an indicator of problems in the estimation of intermediate vs. final uses.

3. Compiling Supply and Use Tables at Constant Prices of a Fixed Base Year

3.1. *Requirements of an Integrated Set of Volume and Price Indices*

Given the data structure set out in Section 2, the question is first of all whether constant price matrices need to be derived for all the different layers of use matrices, e.g. trade margins and taxes less subsidies, or whether it would be sufficient to deflate merely the supply matrix at basic prices and the use matrix at purchasers' prices, which is equal to the sum of the use matrix at basic prices and the use matrices for trade and transport margins and taxes less subsidies on products. In the context of traditional constant price national accounts the answer to the first question is clearly affirmative. When the supply and use tables are recalculated in the prices of a fixed base year, all the accounting constraints in the data at current prices should also hold at constant prices. In fact, this is the reason that the 1993 SNA recommends the continued compilation of traditional constant price data as a supplement to the chain index measures. In particular, this means that the difference between values at basic prices and at purchasers' prices should be systematically and explicitly accounted for, and that the output of the wholesale and retail trade industries at constant prices equals the sum over all the cells in the system of wholesale and retail trade margins at constant prices, respectively. One very important use of the complete data set at constant prices is input–output analysis involving more than one year. Input–output analysis requires the links between the supply table at basic prices and the use table at purchasers' prices to be worked out in full detail.

Departing from this observation, it is clear that the deflation procedure must start from the constant price values at basic prices and build up the constant price values at purchasers' prices by adding trade and transport margins as well as taxes on products. This point was already made in the United Nations' *Manual on National Accounts at Constant Prices* (1979) relating to and supplementing the

1968 SNA. This commodity-flow based deflation system has always been used in the Danish national accounting system and thus requires no new developments in connection with the application of the new 1993 SNA.

3.2. *Deflation of Values at Basic Prices*

The 1993 SNA appears tacitly to assume that, at least as far as goods are concerned, there is usually a single price index at the level of basic prices capable of representing the price movements of all sources of supply and all uses of each product. The text contains a lengthy discussion of the interpretation and treatment of price differences between different varieties of the same product, notably in regard to how changes in the composition of a flow should be treated depending on whether such price differences reflect differences in quality or market imperfections. Nevertheless, there is little guidance when it comes to the price movements of these different varieties regardless of compositional changes.

In practice, it may not be realistic to assume that one price index can represent the price movements at basic prices of all supplies and uses. An obvious example is a heterogeneous (differentiated) product where the price movements of domestic suppliers may not coincide—except possibly in the long run—with those of imports of the same product. Indeed, changes in market shares in markets for differentiated products between domestic and foreign suppliers may to a significant degree be the outcome of changing relative prices. Another example is exports vs. domestic uses. In such cases it will normally be appropriate to assign different price indices to the different sources of supply and to the different uses. In reality, for most goods the only price movement at basic prices that may be known on the uses side is that of exports. In most cases, price indices for domestic uses are not likely to be compiled systematically and certainly not at the level of basic prices. A number of countries compile specific import and export price indices, and almost all countries compile unit value indices in their foreign trade statistics. The latter indices, however, are presumably so unreliable at the detailed level as to be of little use in this connection.

Once it is granted that the different sources of supply and the different uses of a given product may have differing price movements, there is *a priori* nothing to assure that deflated supply and use balance. Many different solutions are possible in this case, and the one adopted is likely to reflect the price statistics available in each particular country. The following paragraphs will briefly outline the Danish data situation and how the balance between resources and uses at constant prices is attained in the Danish case.

In Denmark, the primary source of price information is the producer and wholesale price index which provides price indices for domestic supply and imports of in principle all goods except structures, ships and aircraft. In practice, price indices for approximately 1,700 goods are available. No special export price index in compiled. Yet, for many products almost all of the domestic production is exported, so that the prices supplied by manufacturers are likely to be good proxies for export prices. The national accounts department supplements this data set with several hundred price (unit value) indices for homogeneous products as well as 600-plus price indices for services. For heterogeneous products, unit value indices are discarded as basically unreliable at a detailed level. At a much more aggregate level, unit value indices for exports and imports are, however, used for checking purposes.

Two basic models for deflating product flows at basic prices are used in the Danish national accounts which may be termed "deflation from the supply side" and "deflation from the uses side," respectively. The former is used for practically all non-energy products where there is no information on the price levels and movements of domestic uses at the level of basic prices. In this case, domestic supply of a given product is deflated using typically the producer/wholesale price index for domestic supply of the product in question (or the closest representative product), whereas imports of the product is deflated using the corresponding import price index. On the uses side, exports is split into exports of domestic production, to which the domestic production deflator is assigned, and re-exports which is deflated using the import price index for the product in question. Finally, total domestic use at constant prices is calculated as domestic production plus imports less exports, and this magnitude is subsequently distributed proportionally over domestic uses at current prices. This implies that supply and use always balance and that all domestic uses have the same price movement at the level of basic prices.

The other model, deflation from the uses side, is applied whenever the price levels and movements of domestic uses are known for all or many of the uses, and whenever price differences clearly reflect differences in quality in the economic sense of this term. In practice, the information requirement is only fulfilled for energy products where sufficient price information is available thanks to intensive monitoring by various government agencies. Here, a specific price index is assigned to each use of the product at basic prices, and the resulting total use at constant prices is distributed proportionally over the different supplies at current prices, thus enabling domestic output and imports at constant prices to be derived. This model also ensures that supply and use balance for each product. It implies that all sources of supply are deemed to have the same price movements at the level of basic prices. For energy products there is usually no secondary production, so that there is in effect only one source of domestic supply.

3.3. *Deriving Trade and Transport Margins at Constant Prices*

Theoretically, trade and transport margins in year t for a given cell in the use matrix at constant prices are the distribution and transport services actually supplied in connection with that particular flow of goods in year t valued at the prices of trade and distribution services in the base year. The amount of trade and transport service attaching to a given flow of goods at basic prices reflects distribution and transport circuits that may change over time.

The above observation demonstrates that deriving trade and transport margins at constant prices by simply applying the rates of trade and transport margin of the base year to the flows at basic prices of year t deflated to the prices of the base year would be over-simplistic. Nevertheless, the matrix of trade and transport margins in the base year is likely to constitute the best starting point for compiling the use matrices of trade and transport margins at constant prices.

In the Danish case, the rates of trade and transport margins in year $t-1$ at constant prices of the base year are used to establish an initial estimate of margins at constant prices in year t, which is subsequently adjusted in order to take account of known changes in distribution circuits and the structure of wholesaling and retailing as well as price information at the level of purchasers' prices. One important factor in recent years which has led to a reduction of the margin rates at constant prices compared with the current base year 1980 is the shift in the retail trade industry in favour of discount stores offering a smaller amount of service per unit of goods passing over the counter than traditional supermarkets and other retail outlets. The adjustment factor for base year margin rates have been estimated from information on the aggregate gross trade margin rates in various branches of retailing.

3.4. *Deflating Taxes Less Subsidies on Products*

Taxes on products, net, are much more straightforward than trade and transport margins. The simple approach of applying the base year rates to the flows of goods and services at constant basic prices will yield the correct split of the value change into a price and a volume component, no matter whether the product tax (or subsidy) takes the form of a specific tax, a value tax or non-deductible VAT. The implicit deflator resulting from such a calculation will correctly represent changes in taxes resulting from alterations of tax rates and exemptions as a price change and the rest as a volume component.

4. Changing the Base Year

With the passing of time from the base year, economic data series at constant prices become increasingly out of line with reality in terms of relative price influencing economic agents and guiding their actions. Sooner or later it will be necessary to change the base year for the constant price calculation. The new SNA recommends this change every 5 or 10 years. Such a time lapse may be reasonable as regards long-term changes in relative prices between, say, goods and services reflecting *inter alia* differences in productivity change. On the other hand it is clear that major events in particular markets may soon render any given base year obsolete. Energy prices over the last 25 years are a case in point. The 1973 oil crisis seriously inhibited the use of 1970 prices in the seventies, the 1978–79 oil crisis similarly made 1975 prices obsolete in the late 1970s, and the dramatic decline in oil prices in 1986 made both 1980 and 1985 less well-suited as bases for measuring volume changes in the late 1980s and 1990s. These examples illustrate that international conventions to rebase in years ending with 0 and/or 5 are not without problems. One of the merits of using chain indices as the main measures of volume change in economic aggregates is that they are robust in this respect.

Even in calm circumstances, the traditional constant price series (fixed-base Laspeyres indices) present the problem that growth rates change whenever the base year is updated, and this has to be explained to users. As is well-known, substitution effects usually imply that when the base year is carried forward, growth rates for the intervening period fall. Chain indices do not suffer from this drawback.

The observed increase in the substitution bias in recent years together with the inconvenience of having to rewrite economic history each time the base year is updated is the background to BEA's decision to change its featured measures of real output and prices from fixed-weighted to chain-type annual-weighted indexes in connection with the upcoming comprehensive revision of the U.S. national accounts, cf. Landefeld and Parker (1995).

The United States has been publishing chain-type indices as a supplement to the featured fixed-base measures since 1992. Comparisons between the two sets of data indicate the degree of substitution bias for real GDP:

- For 1959–87, the fixed 1987-base measure of annual growth in real GDP is understated by an average of 0.3 percentage point.
- Between 1987 and 1992, there is no significant substitution bias.
- In 1993 and 1994, the fixed-base measure overstates GDP growth by an average of 0.6 percentage point.
- In the first two quarters of 1995, the fixed-base measure overstates GDP growth by 1.0 and 0.6 percentage point respectively, cf. Survey of Current Business (1995).

As noted by Landefeld and Parker, the substitution bias has important consequences for analyses of both business cycles, productivity and investment. The most important factor explaining the observed increase in the substitution bias is the price and quantity developments for computers with the combination of a rapid decline in prices and an explosive growth in quantities. Computers, though, are not the only source of substitution bias. Over the last expansion in the U.S. economy they have accounted for three-fifths of the overstatement.

With a long time series of supply and use tables set forth in Section 2, it is no small task to rebase on a new year. Even though computer programmes run extra years at virtually zero marginal cost, the management of data files and manual plausibility checks involved require considerable resources. One particular time-consuming problem is the case where a product has non-zero values in the supply and use tables of the current year (both at current prices and constant prices of the old base year) but zero values in the new base year, either because the product has disappeared or as a result of changes in nomenclature. For this reason it was decided in Denmark to skip the change to 1985-prices at the detailed level—also considering that the 1985 price structure had already been rendered obsolete by the 1986 decline in oil prices—and retain 1980 as base year until the move to 1990-prices as part of the implementation of the new SNA.

One question of great interest to users is how far backward statistical offices are prepared to carry the new base year. When Denmark switched from 1975 to 1980 as base year in 1984, the supply and use tables were recalculated 15 years backwards to 1966. It has since been decided that 10 years is a more reasonable compromise between the needs of different groups of users. If the base year is changed every 5 years in the future, this convention implies that at any time users will have a time-series of input–output tables at constant prices of a given base year derived from detailed information with a length of between 10 and 15 years. This will be sufficient for most input–output analyses of technological change. Model-builders, however, typically need longer time-series. By deriving conversion factors for each cell from the input–output tables of an overlapping year which is available at constant prices of two different base years, they are able to construct long time-series at a more aggregate level.

5. Deriving Chain Indices

Given a time series of supply and use tables at current prices and at constant prices of one or more base years, the question arises of how chain indices are most practically computed. A Laspeyres volume chain index requires a time series of $t+1/t$ Laspeyres volume indices to be drawn up, whereas a Fisher chain volume index requires this plus a time series of $t+1/t$ Paasche volume indices.

The first choice to make is whether to compute these $t+1/t$ volume indices to be used in the construction of the chain indices from the quantity relatives (value at constant prices of a cell in year $t+1$/value at constant prices of a cell in year t) using the value shares in the supply and use tables at current prices as weights, or from the price relatives [(value of a cell in year $t+1$ at current prices/value of the cell in year $t+1$ at constant prices)/(value of the cell in year t at current prices/value of the cell in year t at constant prices)] using these price relatives to deflate or inflate the supply and use matrices of year t to the prices of year $t-1$ and $t+1$ respectively. As long as there are no empty cells in the matrices of price or quantity relatives, i.e. cells in the supply and use matrices with values in year t but not in year $t+1$ or vice versa, it does not matter which one of these equivalent approaches is used. In practice, however, in a detailed commodity-flow time series such discontinuities are bound to occur. In such circumstances, the deflation/inflation approach is much easier to handle since there will usually be a sound basis for assigning a price relative to an empty cell in the form of the price development in a similar use of the same product, whereas it may be difficult or impossible to know the quantity development of a particular use of a product. It is of course for exactly this reason that the SNA quite generally recommends deflation over quantity extrapolation.

It should be stressed that this empty cell problem in the compilation of chain indices in principle is no different from the discontinuity problems faced when constructing accounts at constant prices of a fixed base year, it is just that it is many times multiplied in size. Whenever a new product appears, or there are new uses of an existing good, base year values have to be assigned to the new cells that have appeared.

A second choice that has to be made is whether to impose additivity on each link in the chain index, or whether to dispense with additivity altogether on the grounds that the chained index will not yield additive data series for more than two years at any rate. If there is a wish to publish the accounts of year t at the prices of year $t-1$, i.e. a bilateral Laspeyres index, with all accounting identities holding for each pair of years, as is currently done in a number of countries, additivity should be imposed in the same way as is done in the usual deflation procedure relating to a fixed base year, the particular Danish application of which was explained in Sections 3.2 and 3.3. In that case, the calculation of the supply and use matrices of year t at prices of year $t-1$ should proceed step by step as in the usual deflation to the prices of a fixed base year, starting by deflating the supply and use matrices at basic prices and then subsequently computing and adding on trade and transports margins and taxes on products, net. More specifically, in this approach the output of the trade and transport industries in year t at year $t-1$ prices have to be derived as the sum of all the relevant trade and transport margins as opposed to being calculated by deflating output of these industries by the $t/t-1$ output price deflators implied by the time series at constant prices of the fixed base year. By the same token, the total of taxes, net, on products in year t at the prices of year $t-1$ will have to be derived by summing the product taxes at year $t-1$ prices over all the cells in the system and not by deflating this component of GDP at a more aggregate level. In case the Fisher formula is used for the chain index, the same remarks apply *mutatis mutandis* to the inflation of the matrices of year t to the prices of year $t+1$.

It is apparent that such an approach is rather burdensome, not least because it requires all the plausibility checks concerning price developments at the level of purchasers' prices, and the concomitant issue of trade and transport margins at constant prices, to be addressed separately for each pair of years in relation to changing base years instead of only a fixed base year. Moreover, if the Fisher formula is used for the chain index, it is questionable whether users will appreciate having three measures of the volume change between years t and $t+1$: the Laspeyres fixed base index, the Laspeyres chain index and the Fisher chain index.

Even though the above approach requires a very large number of calculations, it is important to stress that all the information needed for its implementation, notably the rates of trade and transport margins and product taxes, is contained in the time-series of supply and use tables at current prices and the prices of a fixed base year.

If, on the other hand, additivity of each link in the chain index is not considered to be important, since this additivity breaks down as soon as the comparison is extended to three or more years, it is natural to go about the construction of the chain indices in a somewhat different way which greatly simplifies the computational work. In fact, this is achieved by approaching supplies and uses separately without an explicit calculation of trade and transport margins plus taxes on products for each cell in the system. In contrast to the method described above, uses of products are here deflated/inflated directly at the level of purchasers' prices as opposed to being built up from a deflation/inflation at basic prices by adding margins plus taxes. In concrete terms this means that each cell in the use matrix at purchasers' prices in year t is deflated (inflated) to the prices of year $t-1(t+1)$ using the $t/t-1(t+1/t)$ price relative for that particular cell at the level of purchasers' prices as derived from the time series of supply and use matrices at current prices and prices of the fixed base year. In this approach, output of the trade and transport industries is deflated directly using the output deflators implied by the time series of supply and use matrices at current and constant prices. The same is true of the total of product taxes, net. Since this approach does not explicitly account for the margins and product taxes entering between basic prices and purchasers' prices for each cell in the use matrix and does not impose additivity at any stage of the calculation, it does not result in fully additive tables for any pair of years. However, the supply and use table are each additive separately for pairs of years.

6. Continuity and Aggregation Problems

6.1. *Reasons for Discontinuities*

No matter which of the above two main approaches is used, the problem with empty cells is bound to be a serious one as long as the starting point consists of a commodity-flow system at a detailed level. The reasons why discontinuities occur in a time-series of supply and use matrices are partly real and partly technical. The real ones stem from the introduction of new products, changes in the structure of production and foreign trade. The technical ones first of all have to do with changes in nomenclature regarding products and industries (activities).

More specifically, the real causes of discontinuities are among other things:

—secondary output (industries producing certain products as secondary output one year but not the next);

—imports or exports of a given product one year but not the next;

—intermediate consumption of a given product in an industry in one year but not the next typically revealed by cost-structure surveys, foreign trade by importing enterprise etc.

In each case where there is an empty cell, a price relative will not automatically be generated, and a procedure has to be adopted for assigning a price index to each such cell. In practice, this is one of the major complications encountered when deriving chain indices from detailed product information.

The problem with empty cells can of course be reduced by aggregation. This may be either aggregation in the product dimension, the industry dimension or the final use dimension. When considering the aggregation issue, it is important to observe that when the chain indices are derived from volume data in the form of values at constant prices of a fixed base year, aggregation in the product dimension implies that volume changes below the level of aggregation chosen for the computations will reflect the relative prices of the fixed base year, thus reducing the effect of the chaining. In the extreme case of aggregation of all products into one no growth rate will change.

6.2. *Danish Experience*

In the work on deriving a full set of chain indices from the commodity-flow system underlying the Danish national accounts some experience has been gained regarding the continuity problems discussed in Section 6.1. It was decided to start from the full commodity-flow system containing approximately 1,600 products for the years 1966–80 and more than 2,700 for the period 1980–90. This level of detail in calculating alternative volume measures is comparable to that used in the United States, cf. Young (1992).

Looking at the entire period 1966–90, the technical causes of discontinuities are dominated by changes in product nomenclature. These, in turn, may be divided into small year-to-year changes and comprehensive ones. In the Danish case, the nomenclature for the period 1966–86 was based on CCCN both for domestic production statistics and foreign trade statistics. The commodity balances (products) in the Danish national accounts were defined in terms of an aggregation of the approximately 10,000 goods in the basic statistics into around 3,000 goods for the years in the late sixties on top of which came the services. Over the years, the number of goods in the national accounts breakdown declined to around 2,000 as a consequence of changes in the international customs tariff which necessitated a merging of commodity balances in the national accounts. As a result of these minor changes in nomenclature, therefore, for the years 1966–87 there are many cases of products existing in year t but not in year $t+1$. To cope with this problem the national accounts commodity-flows at constant 1975-prices were recalculated at 1980-prices at the 4-digit level of the CCCN (with certain important exceptions). This aggregation to approximately 1,600 products has greatly reduced the problem for the first part of the period under study.

The comprehensive change of goods nomenclature from CCCN to HS, on the other hand, was bridged over by transition tables between the two systems for the year 1987. In itself, therefore, this change in nomenclature did not give rise to great continuity problems in this respect.

In spite of the aggregation for the first period, the calculations without any aggregation in any of the three dimensions gave rise to an unmanageable number of empty cells. Inspection of this material revealed that the most important source of discontinuity was changes in the product composition of intermediate consumption in manufacturing industries of which there are 82 in the detailed supply and use tables. This reflects an economic reality, since the input structures in manufacturing have a good statistical basis in the form of cost structure surveys etc. In contrast, continuity problems were generally small in regard to final uses (including imports). The part of the calculation giving rise to problems was thus not the expenditure measure of GDP and its components but the output measure requiring the derivation of indices for industry value added by the double deflation method.

In order to reduce the continuity problems to manageable proportions it was therefore necessary to aggregate drastically either in the product dimension or the industry dimension. Given the price of aggregating in the commodity dimension, i.e. that the growth rates below the aggregation level chosen will reflect the relative prices of the fixed base year, which in the Danish case is 1980, it was decided in the first instance to maintain the full product detail and to aggregate instead in the industry dimension. More specifically, it was decided to aggregate manufacturing industry to the one-digit level of ISIC i.e. from the 82 industries previously mentioned to 9 manufacturing industry groupings. The empty cells remaining after this aggregation were then assigned the price relative of a similar use of the same product, or in the case of new products the price relative of the same or a similar use of a similar product.

7. Alternative Volume Measures Derived from the Danish National Accounts

Tables 1–3 and Figures 1–3 present the results of the work done so far on deriving long time-series of volume indices from the Danish national accounts. As mentioned previously, these results are preliminary and will be subject to further investigations and checks. The tables and figures feature average annual

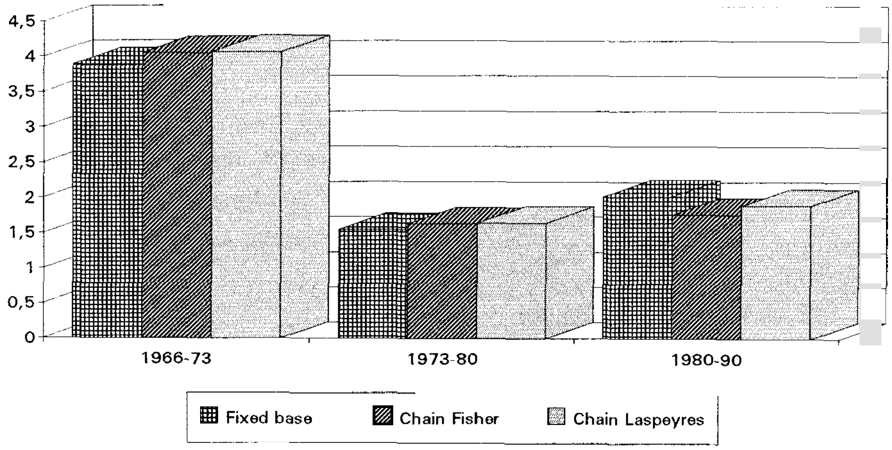

Figure 1. Average Annual Rate of Growth in GDP

rates of change for selected periods as given by Laspeyres fixed base (1980) volume indices, Laspeyres chain indices and Fisher chain indices.

As already mentioned, with the method applied in deriving the chain indices the deflated/inflated supply and use tables used for calculating each link of two years are each additive separately but not taken together. That is why a separate measure is shown for GDP(O) and GDP(E) in Tables 2 and 3. The series labelled GDP(average) is compiled from the deflated/inflated supply and use tables with GDP set equal to the arithmetic average of GDP(O) and GDP(E). GDP from the output side is calculated as the sum of industry value added at basic prices less imputed output of bank services plus taxes less subsidies on products. GDP from the expenditure side is calculated as the sum of final demand components at purchasers' prices one of which is net exports. The real GDP growth rates for the chain indices shown in Figure 1 are those of the expenditure measure of GDP, which in the 1993 SNA is the recommended measure of real GDP.

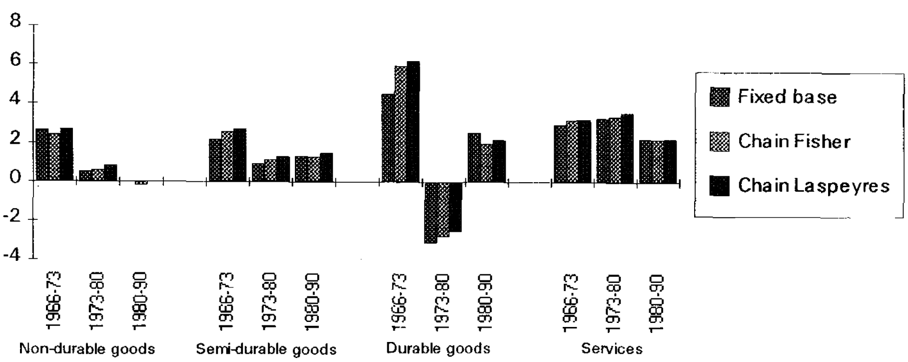

Figure 2. Private Consumption: Average Annual Rate of Growth 1966–73; 1973–80; 1980–90

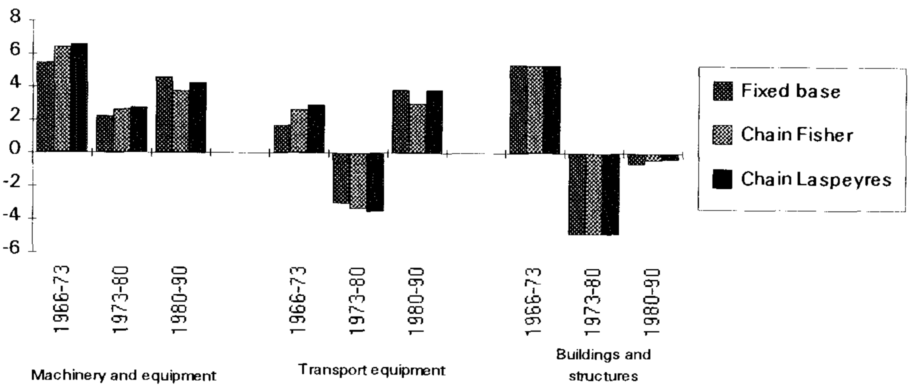

Figure 3. Gross Fixed Capital Formation: Average Annual Rate of Growth 1966–73; 1973–80; 1980–90

The average numerical value of the deviation over all the deflated/inflated supply and use tables (25 years) between GDP(O) and GDP(E) is 0.2 percent. The standard deviation of the percentage deviation is 0.28 percent, and the maximum and minimum are 0.7 percent and 0 percent respectively.

Looking at the growth rates for GDP(O) and GDP(E) in Tables 2 and 3, it is seen that these two sets of figures appear to be sufficiently close as to not call into question the compilation of chain indices for expenditure components of GDP and industry value added within the same framework.

Turning to the GDP growth rates in Figure 1, it is seen that for the selected time periods shown the deviations between the three measures have the sign one would expect from the fact that the fixed base year is 1980 and the substitution effects normally at work in the medium and long run. It is perhaps remarkable that the fixed base measure performs relatively well when compared with the theoretically preferable Fisher chain index, although the latter shows a significantly lower annual rate of change for the last sub-period 1980–90. When interpreting this result it has to be kept in mind, though, that the fixed base year (1980) in this case happens to lie roughly in the middle of the 25-year period under consideration. If the price structure used for the fixed base calculation were instead 1990-prices, it is likely that the picture would be less favourable as regards the ability of the fixed base index to track the true development of real GDP during the earlier sub-periods.

If one goes on to consider the components of GDP as well as industry value added, the divergences between the two chain indices on the one hand and the fixed base measure on the other are more pronounced for certain components, notably consumer durables, gross fixed capital formation and value added in the industries mining and quarrying (North Sea oil and gas), electricity, gas and water and business services.

Looking finally at the ability of the Laspeyres chain index to approximate the Fisher chain index, it turns out that on the whole the approximation is rather good. As one would expect, it is clear from Tables 1–3 that the effect of chaining

TABLE 1

LASPEYRES FIXED BASE INDICES (1980 PRICES)

Average annual rates of change

	1966–73	1973–80	1980–90	1966–90
GDP				
GDP (output)	3,894	1,553	2,028	2,429
GDP (expenditure)	3,894	1,553	2,028	2,429
GDP (average)	3,894	1,553	2,028	2,429
Components of GDP				
Final consumption of households	2,890	1,109	1,259	1,688
Non-durable goods	2,654	0,557	−0,027	0,919
Semi-durable goods	2,183	0,925	1,300	1,447
Durable goods	4,494	−3,113	2,511	1,403
Services	2,950	3,245	2,211	2,727
Collective consumption	5,874	4,093	1,053	3,326
Gross fixed capital formation	5,062	−3,090	1,572	1,181
Machinery and equipment	5,469	2,223	4,584	4,146
Transport equipment	1,654	−3,069	3,827	1,141
Buildings and structures	5,357	−4,895	−0,680	−0,226
Exports	6,264	3,475	4,771	4,823
Imports	6,360	0,524	2,882	3,184
Industry gross value added				
Agriculture etc.	−0,886	3,231	3,526	2,134
Mining and quarrying	9,430	1,176	42,192	19,287
Manufacturing	4,726	1,994	1,008	2,369
Electricity, gas and water	4,231	5,652	4,330	4,685
Construction	1,572	−2,606	−0,993	−0,728
Trade, hotels and restaurants	3,535	0,930	2,362	2,282
Transport, storage and communication	2,983	0,035	4,119	2,582
Finance and insurance	8,045	−2,373	2,624	2,670
Dwellings	9,809	2,342	0,990	3,888
Business services	1,755	6,436	6,164	4,937
Other market services	1,431	1,962	0,513	1,201
Non-market producers excl. government	−6,322	0,471	1,813	−1,014
Producers of government services	6,468	4,558	1,555	3,843
Breakdown of gross value added in manufacturing				
Food, beverages and tobacco	3,407	3,624	2,504	3,092
Textile, clothing and leather	3,683	0,672	−2,103	0,365
Wood products incl. furniture	5,136	−1,633	1,676	1,687
Paper, printing and publishing	3,584	0,118	−0,924	0,677
Chemical and petroleum industries	7,780	5,812	1,690	4,635
Non-metallic mineral products	6,519	−3,233	−2,404	−0,131
Basic metal industries	−3,391	6,533	2,165	1,747
Fabricated metal products	5,348	2,414	0,961	2,648
Other manufacturing industries	4,789	−1,888	3,218	2,151

is more important than the choice of index number formula for the chain index. Significant deviations between the two sets of chain indices are, however, observed for gross fixed capital formation in machinery and transport equipment.

8. CONCLUSION

The results of the analysis carried out on the Danish national accounts database may be summarised as follows:

TABLE 2

LASPEYRES CHAIN INDICES

Average annual rates of change

	1966–73	1973–80	1980–90	1966–90
GDP				
GDP (output)	4,041	1,547	1,824	2,384
GDP (expenditure)	4,073	1,649	1,898	2,454
GDP (average)	4,057	1,598	1,861	2,419
Components of GDP				
Final consumption of households	3,291	1,450	1,262	1,905
Non-durable goods	2,683	0,832	−0,039	1,003
Semi-durable goods	2,714	1,288	1,467	1,777
Durable goods	6,195	−2,556	2,161	1,907
Services	3,211	3,540	2,208	2,887
Collective consumption	5,874	4,093	0,926	3,271
Gross fixed capital formation	5,378	−2,973	1,545	1,295
Machinery and equipment	6,601	2,731	4,237	4,477
Transport equipment	2,883	−3,548	3,819	1,346
Buildings and structures	5,278	−4,912	−0,416	−0,142
Exports	6,605	4,085	4,768	5,100
Imports	7,135	1,028	2,808	3,523
Industry gross value added				
Agriculture etc.	0,105	1,960	3,846	2,193
Mining and quarrying	1,315	−1,283	41,349	15,516
Manufacturing	5,482	2,296	0,682	2,534
Electricity, gas and water	7,093	1,844	6,773	5,403
Construction	1,626	−3,133	−1,211	−0,961
Trade, hotels and restaurants	3,067	0,666	2,383	2,077
Transport, storage and communication	3,478	0,968	3,051	2,563
Finance and insurance	7,801	−2,306	2,427	2,541
Dwellings	9,569	2,289	0,901	3,768
Business services	4,543	6,630	6,168	5,826
Other market services	1,267	1,768	0,517	1,099
Non-market producers excl. government	−5,100	0,560	1,715	−0,653
Producers of government services	6,099	4,317	1,309	3,563
Breakdown of gross value added in manufacturing				
Food, beverages and tobacco	3,112	4,168	1,675	2,816
Textile, clothing and leather	3,679	0,441	−1,569	0,524
Wood products incl. furniture	5,995	−1,419	1,462	1,904
Paper, printing and publishing	3,701	−0,055	−1,348	0,480
Chemical and petroleum industries	10,734	5,399	1,754	5,371
Non-metallic mineral products	6,904	−3,871	−1,966	−0,032
Basic metal industries	3,876	4,413	0,567	2,639
Fabricated metal products	6,078	2,884	0,676	2,872
Other manufacturing industries	5,938	1,259	3,064	3,360

Firstly, it appears to be feasible to derive both types of recommended volume measures in the 1993 SNA, i.e. chain indices and traditional fixed base constant price data, within the same basic framework consisting of the supply and use tables. In particular, it appears to be possible to avoid prior aggregation in the product dimension for the calculation of the chain indices. The compilation of chain indices for industry value added does, however, necessitate a certain aggregation in the industry dimension in order to avoid serious continuity problems.

TABLE 3

FISHER CHAIN INDICES

Average annual rates of change

	1966–73	1973–80	1980 90	1966–90
GDP				
GDP (output)	4,048	1,572	1,796	2,382
GDP (expenditure)	4,058	1,635	1,773	2,394
GDP (average)	4,053	1,604	1,784	2,388
Components of GDP				
Final consumption of households	3,106	1,236	1,149	1,741
Non-durable goods	2,417	0,590	−0,175	0,798
Semi-durable goods	2,578	1,120	1,279	1,610
Durable goods	5,941	−2,814	1,940	1,665
Services	3,185	3,370	2,170	2,814
Collective consumption	5,874	4,093	1,004	3,304
Gross fixed capital formation	5,281	−2,991	1,287	1,155
Machinery and equipment	6,414	2,604	3,738	4,177
Transport equipment	2,623	−3,361	2,971	0,982
Buildings and structures	5,276	−4,910	−0,428	−0,148
Exports	6,356	3,807	4,414	4,798
Imports	6,899	0,843	2,667	3,342
Industry gross value added				
Agriculture etc.	−0,091	2,598	3,569	2,207
Mining and quarrying	1,046	−1,315	43,516	16,149
Manufacturing	5,571	2,324	0,682	2,567
Electricity, gas and water	7,426	2,110	6,993	5,670
Construction	1,702	−3,012	−1,168	−0,885
Trade, hotels and restaurants	3,169	0,750	2,381	2,131
Transport, storage and communication	3,447	0,963	2,979	2,522
Finance and insurance	7,839	−2,298	2,450	2,564
Dwellings	9,581	2,288	0,914	3,777
Business services	4,446	6,595	6,149	5,779
Other market services	1,433	1,823	0,517	1,164
Non-market producers excl. government	−5,169	0,560	1,712	−0,676
Producers of government services	6,192	4,411	1,393	3,652
Breakdown of gross value added in manufacturing				
Food, beverages and tobacco	3,152	4,250	1,842	2,992
Textile, clothing and leather	3,985	0,652	−1,706	0,614
Wood products incl. furniture	6,044	−1,382	1,868	2,099
Paper, printing and publishing	3,658	0,062	−1,186	0,571
Chemical and petroleum industries	10,643	5,947	1,680	5,473
Non-metallic mineral products	7,035	−3,676	−1,948	0,071
Basic metal industries	4,202	6,087	1,291	3,519
Fabricated metal products	5,907	2,790	0,580	2,755
Other manufacturing industries	6,336	0,594	3,099	3,289

Secondly, the deviations in each link in the chain indices between GDP derived from the output side and from the expenditure side are typically small enough to allow chain indices for GDP and its components to be presented alongside chain indices for industry value added.

Thirdly, for total GDP it would seem that traditional constant price data are reasonably representative of the volume change over a time-span of around 10 years on either side of the fixed base year. The ability of traditional constant price data to track the true volume change is less satisfactory as regards certain components of GDP notably consumer durables and gross fixed capital formation in machinery and transport equipment. The same is true of value added in certain industries.

Fourthly, on the whole a Laspeyres chain index provides a rather good approximation to the theoretically preferable Fisher chain index. Significant deviations are nonetheless observed in the case of gross fixed capital formation in machinery and transport equipment.

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