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National Accounts in a Time-series Perspective

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1. Introduction

This paper emanates from the work carried out by Statistics Denmark after moving to System of National Accounts 1993 (SNA93) in order to maintain unbroken time-series back to 1966.

All countries having undertaken a comprehensive revision of their national accounts e.g. in connection with the move to SNA93 face the same problem: how can the long time-series of national accounts data be preserved. Just making a break in the time-series from a certain year would entail a big loss of information on the evolution and structure of the economy, which would be a major obstacle to empirical analysis. The paper describes a way of maintaining long time-series which is not exceedingly resource demanding.

The paper starts by focusing on the need for consistent time-series when modelling and interpreting economic behaviour. It then outlines the general approach used in revising the Danish national accounts back to 1966, highlighting the importance of separating effects from new definitions, updated sources and methods and new classifications. The separation is carried through to the level of input-output tables. The paper then moves on to introduce a number of techniques used, some of which are quite sophisticated, in order to facilitate the use of information at a detailed level although the revision itself is carried out at a higher level of aggregation. Such an example is the transformation from former to new classifications. Finally, an overview of separated effects on main aggregates and selected input-output figures is presented in a time-series framework.

2. The need for consistent time-series

"When can a country claim it has "implemented SNA93"?..... A judgement has to be made, based on issues such as how well the critical parts of an economy have been covered in the accounts, the main interests of the major users of the accounts and the length of time-series on the basis of SNA93."[i]

There is no doubt that the time-series aspect of national accounts is an important aspect. First, it is essential to have long consistent time-series on all main aggregates for the purpose of monitoring the evolution of an economy. Secondly, to be able to observe changes in the structure of an economy and partly to facilitate econometric modelling and forecasting, long consistent time-series on a less aggregated level are needed - e.g. the level of input-output tables. The crucial point is consistency in the meaning of complete time-series measuring the same phenomena in the same way over a certain period. This is in fact the problem to be handled e.g. moving to SNA93.

3. Revision of Danish national accounts back to 1966

Concerning national accounts data back to 1966, there have been only two general, comprehensive revisions of all sources and compilation methods underlying the accounts. The first revision was published in 1978 making the accounts fully consistent with SNA68, and partly consistent with the European System of Integrated Economic Accounts, second edition (ESA79). The second revision took place in 1997 covering the period 1988-1996. As part of the changeover to ESA95/SNA93, a general revision of sources and methods involving a total overhaul of all statistical sources and compilation methods behind the national accounts was undertaken. At that time, it was also decided to revise the national accounts back to 1966 in a way that was not exceedingly resource-demanding but at the same time capable of maintaining long consistent time-series.

3.1 Overall strategy

The overall strategy has been to break down all revisions into the following three categories (following the 1997 revision):

- revisions of sources and methods
- revisions of classifications

[i] OECD, February 2000.

- changeover to ESA95/SNA93

The strength of this breakdown is obvious for verification and interpretation of the revised national accounts.

In general, the backward calculations are based on former growth rates and levels/structures from the benchmark-years 1988-1992 for which the new compilation system was first implemented. This implies a default assumption of correct former national accounts growth rates in all cases where there is no evidence to the contrary. The assumption is in line with Danish national accounting practices, where new sources or errors discovered are only taken into account when calculating growth rates and thereby do not have an immediate effect on levels/structures. The revision of the latter is left over for general, comprehensive revisions.

The functional part of the national accounts, i.e. the part describing production and supply and use of goods and services, is revised at the level of io-tables. In Denmark, these tables are now based on 130 production/import-industries (based on NACE rev.1), 5 groups of imports not broken down by industry, 5 groups of primary factors and 96 groups of final use (73 groups of private consumption expenditure based on COICOP and including Non Profit Institutions Serving Households - NPISH, 11 groups of consumption of general government, 11 groups of capital formations and exports) plus Financial Intermediation Services Indirectly Measured - FISIM).

In addition, the institutional sector accounts have been revised, but they are not within the scope of this paper.

Concerning the volume measurement in national accounts, the revision includes a base year change from 1980 to 1995 (although the benchmark-years had 1990 as base year at the time of computations, the national accountants were in the process of changing the base year to 1995), which is of importance for io-tables measured in base year prices. The revision also introduces - for the first time in Danish national accounts - Laspeyres chain volume indices (1966-1988) based on io-tables in previous year prices.

3.2 Revisions of sources and methods

Revisions of sources and methods are in general based on former growth rates and levels from the benchmark-year 1988. Three types of exceptions from the general method have been applied:

- specific additional information taken into account
- additional information on benchmark-years 1989-1992 taken into account
- an examination across industries of compensation of employees as share of gross value added has been taken into account

Specific additional information includes the Danish "Household Budget Survey 1981", which is taken into account in the revision of private consumption in areas where the survey is known to have high accuracy.

Also included is the Danish "Census of Population and Housing 1970" in areas such as housing, compensation of employees and employment. E.g., compensation of employees and employment are targeted at the 1970 levels - by which procedure it is assumed that errors have emerged gradually over time.

Gross fixed capital formation (machines and equipment, transport equipment and buildings and structures), for which there has been considerable revisions in the benchmarks-years, has been revised at the level of individual goods, which at the level of gross fixed capital formation groups gives rise to new growth rates.

By taking into account additional information on benchmark-years 1989-1992 it is possible to assess whether 1988 represents adequately the revisions of sources and methods for each series in question. In some cases, a weighted average of all benchmark-year revisions has been used to find a starting level for the backward calculations.

For each industry, a main plausibility check has been to examine compensation of employees as share of gross value added before and after revisions. In a number of cases, this has led to further investigations and use of other methods.

The backward calculations of revised series give rise to functional national accounts where supply and use do not correspond to each other because the growth rates are applied to new levels. Because of this, it is necessary to balance the accounts. The balancing is carried out recursively by fixing the yearly GDP growth rates in the interval between the two growth rates calculated from the production and expenditure side respectively, subject to the condition that the resulting GDP growth rate mirrors the former growth rate as far as possible within this range. Table 3.2.1 shows the differences in GDP calculated from production and expenditure side as share of GDP calculated from the production side prior to balancing the accounts. It should be noticed that only three years show differences on more than 0.5 percent of GDP, with the highest being 0.64 percent.

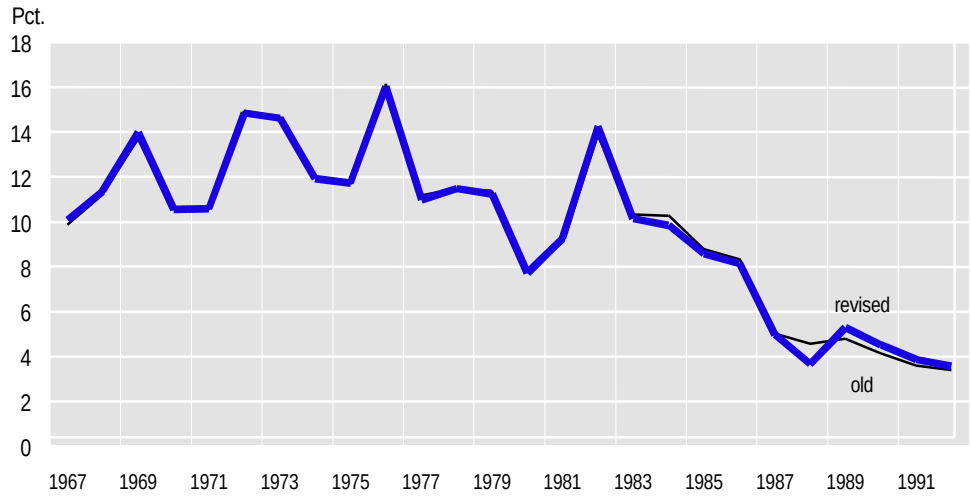
Table 3.2.1 Pre-balancing supply/use differences in percent of GDP

Year	Difference in percent	Year	Difference in percent
1987	-0.14	1976	0.19
1986	-0.42	1975	0.14
1985	-0.64	1974	0.11
1984	-0.40	1973	0.28
1983	-0.33	1972	-0.25
1982	0.49	1971	0.48
1981	0.17	1970	0.58
1980	-0.35	1969	0.14
1979	-0.29	1968	0.13
1978	-0.59	1967	0.29
1977	-0.46	1966	-0.23

The supply-side is adjusted to the new GDP values by manual and proportional adjustments to specific industries (in general industries with poor data sources available). The user-side adjustments are placed on specific groups of consumption and in rare occasions on gross fixed capital formation.

Figure 3.2.1 shows the growth rates of the former and the revised GDP figures. As expected - due to the methods used - the growth rates are in general alike with the exception of the growth rate between 1987 and 1988 for which strong evidence was found that the former growth rates had to be revised. It must be emphasized that the robustness of the 1987 calculations are verified by looking at the pre-balancing supply/use difference in percent of GDP for 1987, which is as low as –0,14 percent.

Figure 3.2.1 Growth rates of former and revised GDP figures



Revisions of sources and methods with respect to GDP are based on the price level of purchasers' price VAT included. A breakdown into basic price, wholesale trade margin, retail trade margin, net taxes on products and VAT is subsequently needed. VAT is calculated based on VAT as share of purchasers' price based on revised 1988 figures extrapolated backward using former growth rates. In general, net taxes on products are kept

untouched. The breakdown by use of category of trade margins is determined in the io-tables, and finally basic prices are determined as residuals.

As far as the io-tables are concerned the revisions of sources and methods are based on the former io-tables (1966-1988) in combination with the revised 1988 io-table. The strategy has been to adjust the structures of the former io-tables for structural changes in the benchmark-year 1988. Thereby structural io-changes in 1988 (which are aggregated effects) are assumed relevant back to 1966. This assumption is in line with prior assumptions.

The adjustment method used is based on one adjustment-factor-matrix calculated by dividing revised 1988 io-table by the former 1988 io-table cell by cell. The adjustment-factor-matrix is then multiplied - cell by cell - with the former io-tables (1966-1987) thereby producing unbalanced revised io-tables. Each table now has to be balanced with the border totals from the balanced national accounts. An automatic iterative procedure is used to balance the tables. However, major supply/use differences have been looked into and handled manually.

3.3. Revisions of classifications

Conversion from former to new industry- and consumption-groupings is an essential part of maintaining consistency in a time-series perspective - the consistency of classifications/measuring the same phenomena over time. Relatively large resources have been used to ensure, that the new groupings mirror the detailed historic developments in the supply and use of specific goods and services and intermediate consumption- and compensation of employees-quotas because the former industry-groupings reflect market/non-market, activity and function whereas the new industry-groupings are based purely on activity. It is evident that specific activity – and thereby the basis for new industry-groupings - is very closely linked with production of specific goods and services. A link that is essential to maintain for the purpose of solid founded structural analysis. Of course, computations on a more detailed level than described in section 3.1 are required. All revisions of classifications are calculated based on data already revised due to new sources and methods[ii].

3.3.1 Industry-conversion of output

The objective of the following computations is to end up with year-specific conversion-keys at industry level reflecting both the 1988-conversion-key and the supply-/user-change over time at the level of specific goods and services *from now on named product- or NANO-level (national accounts number)*. *The new and former industry groupings are named NA130 and NA117 respectively (national accounts 130 and 117 industry grouping)*. The year-specific conversion-keys are to be used on all price levels.

The changeover of the NANO product-nomenclature from being CCCN-based[iii] from 1966 to 1988 to be based on the HS[iv] nomenclature (1988-) limits the complexity of the conversion, but the problems are minimised due to the existence of a double-coded supply- and user-table for 1988.

The calculation of the year-specific conversion-keys requires several steps, which are explained in detail through an example in appendix A. The overall idea is to look at the 1988-conversion at product level, compare this conversion with a simulated conversion only using the 1988 conversion-key at industry level and thereby calculate a correction-factor matrix at product level. Subsequently it is possible to combine the use of the 1988 conversion-key at industry level and the correction-factor matrix on the supply- and user-matrices for the period 1966 to 1987. The results of these year-specific conversions are then used to form conversion-keys at industry level. Finally, to eliminate transition problems between 1987 and 1988, the conversion-key of 1987 is made equal to the conversion-key of 1988 and differences are being smoothed over the period 1966 to 1986.

A good example of the usefulness of the above calculations is the conversion of the former NA117 industry "Repair of machinery" to the new NA130 industries "Manufacture of construction materials of metal etc.",

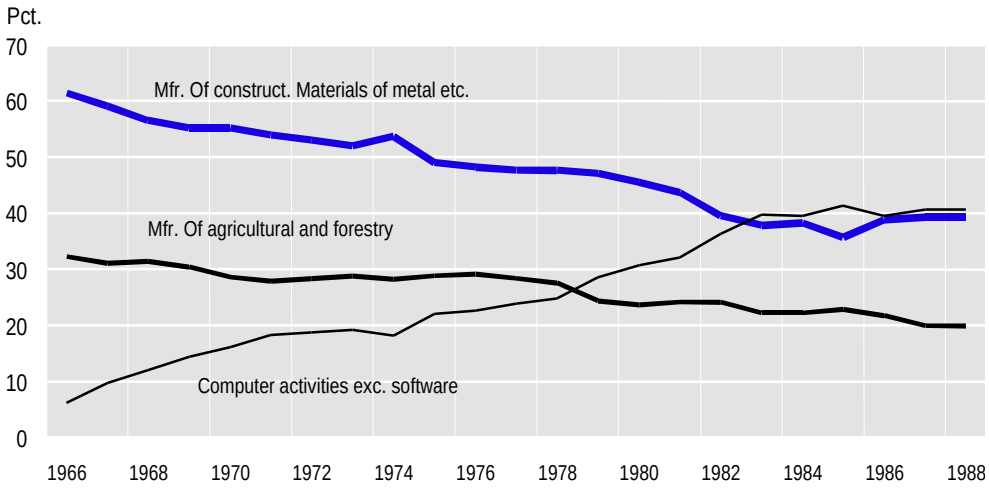
[ii] Year-specific revisions across specific goods and services within same supply-/ use-group (industry-/ consumption-group) are assumed identical.

[iii] CCCN: Customs Cooperation Council's Nomenclature

[iv] HS: Harmonized System

"Manufacture of agricultural and forestry machinery" and "Computer activities ex. software consultancy and supply". The evolution of this specific conversion-key is shown in figure 3.3.1. It is evident, that a fixed conversion key from 1988 used back to 1966 would cause "Computer activities ex. software consultancy and supply" to have an unacceptable high production in the early years although computers were virtually non-existing in the sixties.

Figure 3.3.1 Conversion-key example "Repair of machinery" converted into new industry-groupings



3.3.2 Industry-conversion of intermediate consumption

The conversion of intermediate consumption by industry is not based on the same techniques as those used in the case of output. This is because intermediate goods and services can be used across a wide range of industries, whereas products on the output side usually originate from no more than one or a few industries. This fact makes the intermediate consumption conversion key at NANO-level much more difficult to approximate correctly.

The industry-conversion method chosen for intermediate consumption is instead based on industry-converted output, intermediate consumption ratios for 1988 at NA130-level and year-specific intermediate consumption ratios at NA117-level. The overall idea is to adjust the intermediate consumption ratios for 1988 simply by maintaining consistency with year-specific intermediate consumption ratios at NA117-level subject to the year-specific output conversion-keys at industry level calculated in 3.3.1. As for output, the results of the year-specific conversions are used to form conversion-keys at industry level. The calculations of the year-specific conversion-keys are explained in detail through an example in appendix B.

VAT and taxes are converted using the year-specific intermediate consumption conversion keys at industry level.

3.3.3 Conversion of consumption-groupings

The conversion of the 73 new consumption-groupings is straightforward compared with the conversion of output and intermediate consumption because a conversion-key at NANO-level was produced for all benchmark-years (1988-1992). Products not covered by the 1988 conversion are converted using the year-specific conversion-keys at the level of consumption-groupings (calculated on the basis of products covered).

As for intermediate consumption, VAT and taxes are converted using the year-specific consumption-groupings conversion keys.

3.3.4 Industry-conversion of compensation of employees and employment

The industry-conversion of compensation of employees follows in principle the method applied for intermediate consumption, and is based on industry-converted output, compensation of employees quotas for 1988 at NA130-level and year-specific compensation of employees quotas at NA117-level. In addition, year-specific compensation of employees conversion-keys at industry level are computed. For a few specific industries, the resulting compensation of employees at NA130-level is adjusted in order to secure plausible values of compensation of employees as quotas of gross value added. The corrections do not interfere with continued consistency between compensation of employees on NA117- and NA130-level given the structure of the compensation of employees conversion-keys.

A first estimate of industry-converted employment is based on the year-specific conversion keys for compensation of employees. This estimate has to be revised in order to take account of different part-time frequencies within specific NA117-industries that may show up on the NA130-level. This is done by imposing the 1988 compensation of employees per employed person on 1987 and subsequently calculating backwards the figures based on growth rates of key-converted employment at NA130-level. Finally, the compensation of employees at NA130-level is adjusted proportionally to ensure consistency with the compensation totals before industry-conversion.

3.3.5 Industry-conversion of foreign trade

To construct io-tables with revised classifications an industry-conversion of import is needed. It is assumed that products imported are produced in the same industries, as is the case for similar products domestically produced. For that reason, import at NA117-level is not industry-converted using the conversion-keys of Danish output. This is because these keys reflect the domestic product composition, which in many areas might be dramatically different from the imported product composition (many imported products are not produced domestically and many domestically produced products are not, or has not been, subject to considerable competition from imported products). Instead, the conversion is based on 1988 information on domestically produced HS-based NANO-products at NA130-level. This information on NANO/NA130-linkings is converted to the CCCN-based NANO-nomenclature utilising a double coded supply- and use-table for 1987. The linkings are calculated both on the 6- and 4-digit NANO-level and supplemented with a 1992 file on linkings for products not produced domestically. Based on import information at NANO-level (before any revisions) from 1966 to 1987, year-specific distribution scales at NA130-level are computed which subsequently are used to distribute sources and methods revised import totals across NA130-industries.

It is assumed that within a specific industry the product composition exported does not deviate too much from the composition used domestically. Exports at NA117-level is therefore converted using the year-specific conversion-keys of Danish output.

3.3.6 Input-output tables with revised classifications

As far as the input-output tables are concerned the conversion to the new classifications proceeds in two steps. First, the io-tables incorporating the effects of new sources and methods but still on the former classifications are converted using the former calculated year-specific conversion keys based on output, intermediate and final consumption respectively (imports by industry are converted based on Danish output). In a second step, the result of this rather crude conversion is then adjusted (or fine-tuned) by applying information for the first year (1988) in the current set of io-tables. For the year 1988 the transition to the new classifications was carried out in a much more sophisticated way than by using conversion keys. Among other things, a lot of information at product and sub-industry level was incorporated.

The idea behind this second step is simple. By comparing the result of a crude conversion by means of conversion keys with the result of a more detailed and sophisticated conversion for the year 1988, a correction-factor matrix can be derived which incorporates the additional information taken into account for the year 1988. By assuming that the structure of this matrix is constant over the period 1966-88 it is possible to make a

transition to new classifications which is better than simply applying conversion keys, while at the same time not being very resource-demanding.

In this second step, the adjustment factor matrix derived for 1988 is multiplied – cell by cell – with the matrices resulting from step 1. The result is a set of input-output tables on the new classifications, which are not balanced to the border totals (industry and final use totals) derived in an earlier stage (see sections 3.3.1. – 3.3.5). An automatic iterative procedure is used to balance the matrices.

3.4 Revised definitions (SNA68/ESA79 to ESA95/SNA93)

Implementation of revised definitions requires special calculations and new data-sources across most areas affected. The default method used to quantify the effects of revised definitions for the period 1966 to 1987 would be to base the calculations on 1988 effects, extrapolated backwards by the use of some meaningful indicators. The problem is to find appropriate indicators! Two examples are:

- purchased and own-account software recorded as gross fixed capital formation
- financial leasing
- consumption of fixed capital on roads, bridges, etc.

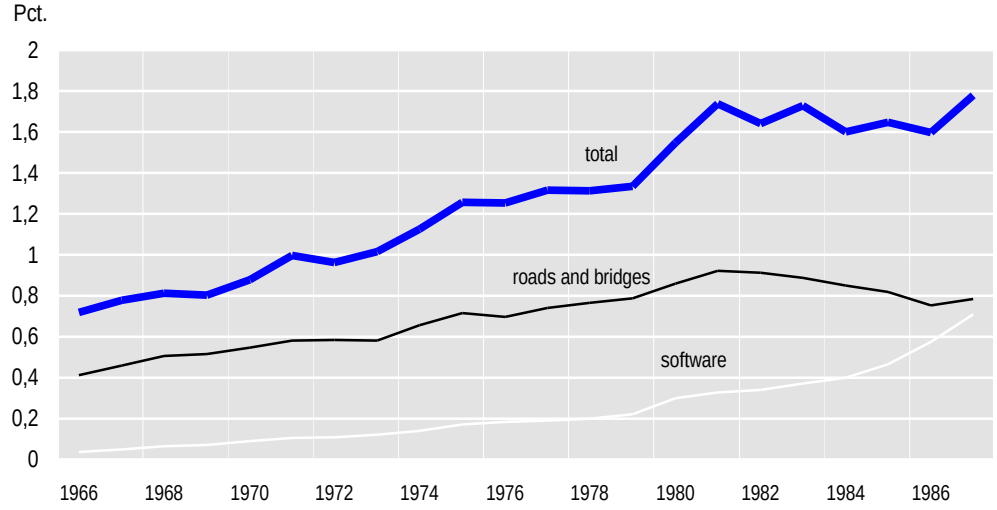
Concerning purchased and own-account software, it is evident that the relative importance has increased dramatically over the period, and new data sources are to be used to quantify the growth. The most important sources being compensation of employees statistics from the Danish employers' association concerning IT related compensation of employees and IT-censuses from the years 1970, 1973 and 1975.

Concerning financial leasing, this phenomenon does not exist in Denmark before the mid-seventies. New data sources used to quantify the growth include leasing statistics beginning in 1986, statistics beginning in 1980 from LeaseEurope (an association of European leasing companies) as well as various newspaper articles.

Concerning consumption of fixed capital on roads, bridges, etc., the assumption of infinite lifetime is abandoned and consumption of fixed capital has to be calculated. The calculations are based on capital stock statistics.

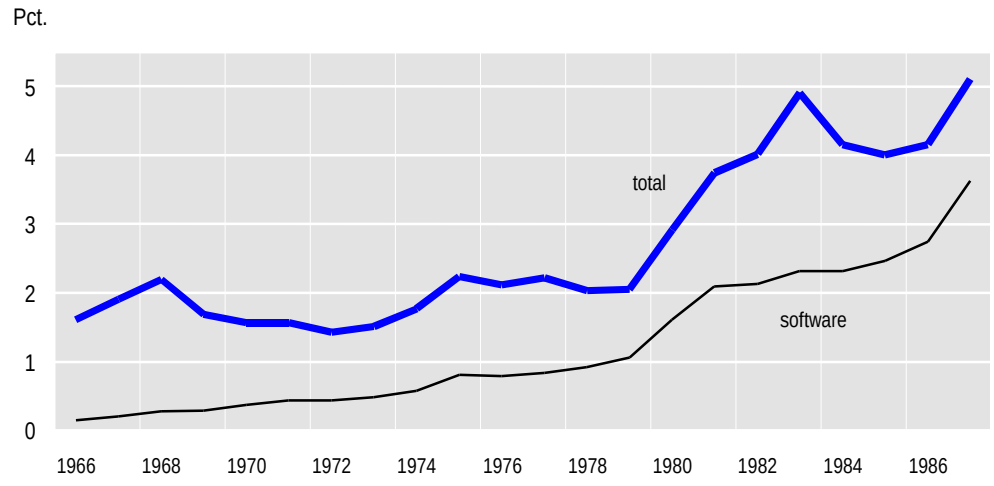
The effect on the GDP level of the new definitions is shown in figure 3.4.1. It is seen, that the effect is increasing over the years from 0.72 percent in 1966 to 1.78 percent in 1987. The effects of the individual definitional changes on GDP are shown in appendix C.

Figure 3.4.1 Effect on the GDP level of new definitions



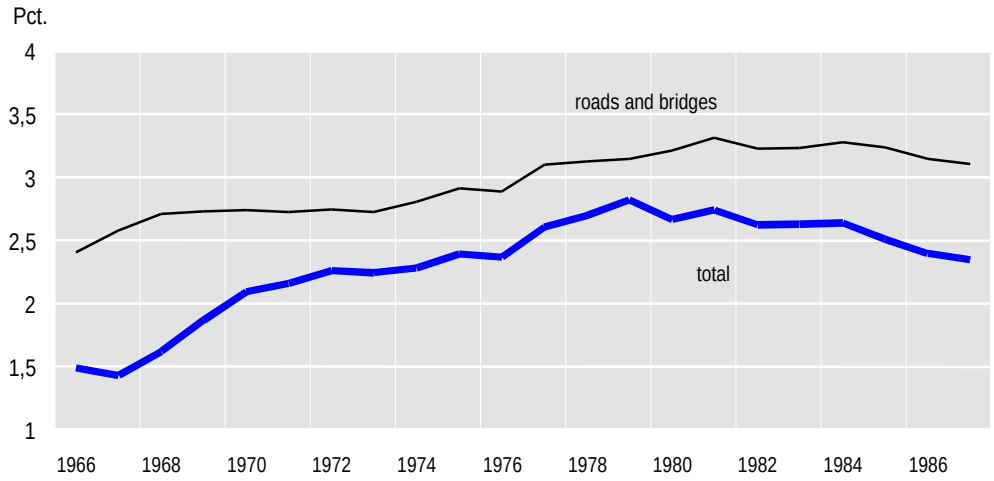
A number of new definitions affect gross fixed capital formation with increasing magnitude over the years. In 1966, these new definitions account for 1.6 percent of total gross fixed capital formation growing to 5.1 percent in 1987 (see figure 3.4.2).

Figure 3.4.2 Percentage change in gross fixed capital formation plus valuables due to revised definitions



In addition, consumption of general government is heavily affected by the revised definitions. Figure 3.4.3 show the increase due to revisions as quotas of total consumption of general government. The effects on consumption of general government from specified revised definitions are shown in appendix C.

Figure 3.4.3 Change in consumption of general government due to revised definitions



3.5 Constant price calculations

The purpose of the constant price calculations is to create constant price io-tables with 1995 as base year for the period 1966 to 1987. Furthermore, real growth rates calculated as Laspeyres chain volume indices are produced (1966 to 1988) to comply with ESA95 and to avoid well-known problems (due to substitution effects) with fixed-base-year constant price calculations.

The constant price calculations in the Danish national accounts in general are based on basic price indices at product- and industry-level on the supply-side together with energy products and exports on the user-side. For all other uses, constant price residuals are distributed in proportion to current price distributions. Furthermore, base year rates of wholesale and retail trade margins, customs duties, net taxes on products, VAT and compensation of employees in connection with non-market production are used. All other constant price figures including gross value added are calculated using accounting identities.

The constant price calculations for the period 1966 to 1988 are carried out at the level of io-tables. Potentially, cells of an io-table may cover a large number of products whereby implicit cell price indices may reflect a large

number of price indices at the product-level. For that reason, observed changes over time of implicit cell price indices are due to a mix of price- and weight-changes for the products concerned.

The basis for the constant price calculations is the former io-tables at current and constant (1980) prices. These tables are converted (due to revised classifications) using year-specific conversion-keys for output (also used for imports), intermediate consumption and final consumption. The tables are further expanded to handle revised definitions. In addition, special calculations are performed and new data-sources are used to deflate;

- software and computers
- income in kind
- gross fixed capital formation
- general government
- construction

Concerning computers, the constant price calculations in the former national accounts did not take into account the substantial quality improvements observed over the past 25 years. In the revised accounts, the constant price calculations are based on American hedonic price indices corrected for changes in the exchange rate.

Concerning investment in software, a software index was constructed as a weighted average of the computer price index and an index for IT related compensation of employees.

Concerning income in kind, there is no direct information in the former constant price calculations, because this component was only partially included in the national accounts before revision. An example of how this has been overcome is the constant price calculations of the fringe benefit: company cars. In this case, the calculations have been based on the implicit cell price indices for the supply from the industry "rental ex. real property" into the user group "car rental".

Concerning general government, a correction is needed, due to the fact, that for the period 1966 to 1984 the constant price calculations in the former national accounts were based on a yearly compensation of employees index, and not an hourly compensation index, the latter being able to show changes in working hours and holidays correctly as wage changes.

Concerning construction, the main problem in the constant price calculations in the former national accounts concerns all construction except for the big part based on square metres completed. Output price indices for construction are not calculated in Denmark. A concrete ad hoc solution has been to assume yearly productivity gains of one percent for ‘repair and maintenance’ and ‘civil engineering’. This assumption is objective in the sense that it is compatible with the observed productivity gains in construction of new buildings for which the estimates are based on physical quantities and observed prices per square metre.

The calculation of constant price io-tables with 1995 as base year is carried out by converting the year-specific matrices of implicit cell price indices with 1980 as base year into 1990 base year by using the former 1990 io-table in current and constant (1980) prices. This method was chosen because, at the time of computations, the national accounts from 1988 onwards were still only available in constant prices with 1990 as base year. The final conversion into 1995 base year relies on the revised 1995 io-table in current and constant (1990) prices. Missing or unexplainable cell price indices are calculated as / substituted with indices based on yearly growth rates of row price indices.

Real growth rates calculated as Laspeyres chain volume indices are based on new io-tables at the prices of the preceding year. The calculations make use of yearly changes in the implicit cell price indices with 1995 as base year. The indices are calculated for all publication levels because of non-additivity due to chaining.

As expected, the later appearance of a 1988 constant price io-table with 1995 as base year shows differences between deflating at the level of io-tables as opposed to the product-level. It was therefore decided to apply on all constant price io-tables with 1995 as base year a correction factor matrix based on the two 1988 constant price io-tables with 1995 as base year. This does not affect the Laspeyres chain volumes indices because the yearly changes in the implicit cell price indices with 1995 as base year remain unchanged. The result is a series of input-output tables at constant 1995-prices which contains no breaks for the whole period 1966-96.

Figure 3.5.1 Yearly real growth rates (GDP), former and revised

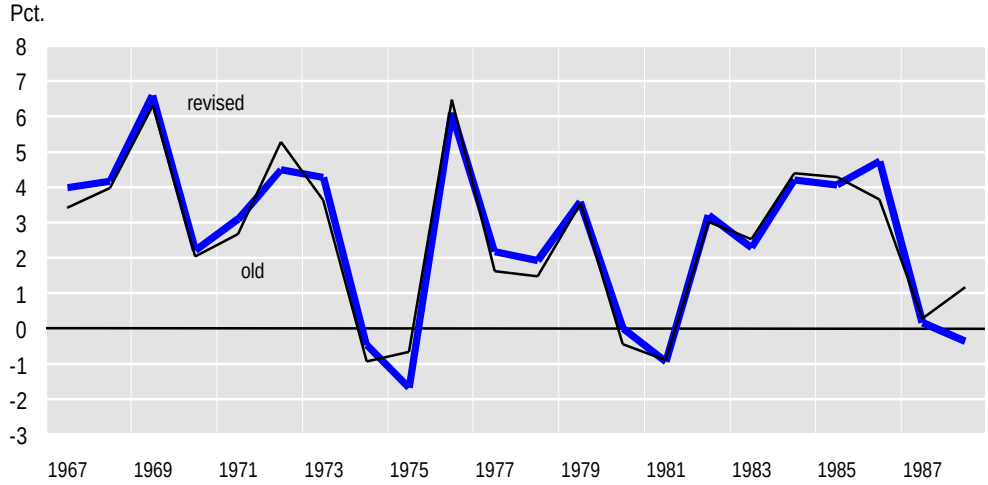


Figure 3.5.1 shows a picture of the economic development which is fairly similar to the former picture. Nevertheless, the new figures do show non-negligible changes to the course of the expansion in 1972-73, the recession in 1974-75, the expansion in 1984-86 and the slowdown in 1987-88. The changes are the combined effect of current price revisions, revisions of specific important deflators and the change to Laspeyres chain volume indices describing real growth rates.

4. Conclusion

The conclusion reached in the Danish implementation of SNA93 is that a significant amount of work has to be put into backward calculations of revisions of national accounts, because the availability of long, consistent time-series is a major issue when evaluating the quality and usefulness of the implementation of ESA95/SNA93.

Another thing learned is the usefulness of being able to separate the effects of the revisions at all levels of detail. This is very useful both for explaining the results obtained, but also in the management of the statistical work.

Finally, we can conclude that the interest from users of the national accounts fully justifies the resources invested in maintaining long time series of national accounts data.

Appendix A

Initially the 1988 industry-conversion of Danish output is split into two parts. In the first part, output at NANO-level is industry-converted alone using the published 1988 conversion-key for output on industry. In the second part, a correction matrix at NANO-level is produced by comparing the result from first part with the actual 1988 industry-conversion. An example will now show the calculation of such a correction matrix.

Part 1: Conversion using published 1988 conversion-key for output at industry level. The example is based on three NANO-products, four NA117-industries converted into six NA130-industries.

Table A.1 1988 conversion-key at industry level

NA117	NA130	Key
NA117nr1	NA130nr1	0.5
NA117nr1	NA130nr2	0.5
NA117nr2	NA130nr2	0.2
NA117nr2	NA130nr3	0.8
NA117nr3	NA130nr3	0.1
NA117nr3	NA130nr4	0.9
NA117nr4	NA130nr5	0.5
NA117nr4	NA130nr6	0.5

Output matrix on NA117-industries:

$$\begin{array}{c} \\ \text{NANO} \end{array} \begin{array}{c} \text{NA117} \\ \begin{bmatrix} 300 & 200 & 100 & 200 \\ 100 & 200 & 300 & 300 \\ 200 & 100 & 300 & 600 \end{bmatrix} \end{array} \qquad (1)$$

Output matrix industry-converted using 1988 conversion-key for output at industry level (table A.1); matrix **O**88:

$$\begin{array}{c} \\ \text{NANO} \end{array} \begin{array}{c} \text{NA130} \\ \begin{bmatrix} 150 & 190 & 170 & 90 & 100 & 100 \\ 50 & 90 & 190 & 270 & 150 & 150 \\ 100 & 120 & 110 & 270 & 300 & 300 \end{bmatrix} \end{array} \qquad (\mathbf{O}88)/(2)$$

Part 2: Correction matrix at NANO-level is produced by comparing the result from first part with the actual 1988 industry-conversion.

Actual 1988 industry-converted output matrix. (Please observe; *at industry level*, this matrix is consistent with a conversion of (1) using the conversion-key in table A.1):

$$\begin{array}{c} \\ \text{NANO} \end{array} \begin{array}{c} \text{NA130} \\ \begin{bmatrix} 100 & 200 & 200 & 100 & 200 & 0 \\ 50 & 90 & 190 & 270 & 100 & 200 \\ 150 & 110 & 80 & 260 & 250 & 350 \end{bmatrix} \end{array} \qquad (3)$$

The correction matrix is made up of two matrices. First matrix shows subtraction percentages on NANO-NA130-cells in **O**88 (2), where the values of these cells are higher than those of the actual 1988 industry-converted output matrix (3); matrix **N** (in percent):

$$\begin{array}{c} \\ \text{NANO} \end{array} \begin{array}{c} \text{NA130} \\ \begin{bmatrix} -33.333 & 0 & 0 & 0 & 0 & -100 \\ 0 & 0 & 0 & 0 & -33.333 & 0 \\ 0 & -8.333 & -27.273 & -3.704 & -16.667 & 0 \end{bmatrix} \end{array} \qquad (\mathbf{N})/(4)$$

Total subtraction value at NANO-level:

$$\begin{array}{c} \\ \text{NANO} \end{array} \begin{array}{c} \text{NA130} \\ \begin{bmatrix} -150 \\ -50 \\ -100 \end{bmatrix} \end{array} \qquad (5)$$

For each NANO-product the total subtraction value must be reallocated to cells where **O**88 (2) are lower higher than those of the actual 1988 industry-converted output matrix (3); reallocation matrix **P** (in percent):

$$\begin{array}{c} \\ \text{NANO} \end{array} \begin{array}{c} \text{NA130} \\ \begin{bmatrix} 0 & 6.667 & 20 & 6.667 & 66.667 & 0 \\ 0 & 0 & 0 & 0 & 0 & 100 \\ 50 & 0 & 0 & 0 & 0 & 50 \end{bmatrix} \end{array} \qquad (\mathbf{P})/(6)$$

The two matrices, **N** (4) and **P** (6) make up the 1988 correction to **O**88.

The two parts of the 1988 conversion is now being applied on output matrices for the years 1966-87. First part is based on the conversion-key in table A.1, while the second part is only relevant for NANO-products already covered by the correction matrices.

The reallocation matrix **P** (6) is further adjusted to meet two specific requirements. Firstly, we want reallocations to a certain NA130-industry to go towards zero, if this is the case before any corrections are applied. Secondly, we want to minimise reallocations between NA130-industries which do not originate from the same NA117-industry (in other words, in this step we do not want to approximate a conversion-key at product level which imply a considerably more complex key on industry-level than is found in 1988. The adjustment is described in the following 1987 example.

1987 output matrix on NA117-industries:

$$\begin{array}{c} \\ \text{NANO} \end{array} \begin{array}{c} \text{NA117} \\ \begin{bmatrix} 400 & 200 & 100 & 200 \\ 100 & 200 & 300 & 400 \\ 200 & 100 & 300 & 500 \end{bmatrix} \end{array} \qquad (7)$$

Output matrix industry-converted using 1988 conversion-key for output at industry level (table A.1); matrix **O**87:

$$\begin{array}{c} \\ \text{NANO} \end{array} \begin{array}{c} \text{NA130} \\ \begin{bmatrix} 200 & 240 & 170 & 90 & 100 & 100 \\ 50 & 90 & 190 & 270 & 200 & 200 \\ 100 & 120 & 110 & 270 & 250 & 250 \end{bmatrix} \end{array} \qquad (\mathbf{O}87)/(8)$$

Year-specific adjustment matrix **F**87(i,j)=**O**87(i,j)/**O**88(i,j) (defined when **P**(i,j)≠0):

$$\begin{array}{c} \\ \text{NANO} \end{array} \begin{array}{c} \text{NA130} \\ \begin{bmatrix} . & 1.263 & 1 & 1 & 1 & . \\ . & . & . & . & . & 1.333 \\ 1 & . & . & . & . & 0.833 \end{bmatrix} \end{array} \qquad (\mathbf{F}87)/(9)$$

Preliminary 1987 reallocation matrix **PPRE**87(i,j)=**F**87(i,j)***P**(i,j):

$$\begin{array}{c} \\ \text{NANO} \end{array} \begin{array}{c} \text{NA130} \\ \begin{bmatrix} 0 & 8.421 & 20 & 6.667 & 66.667 & 0 \\ 0 & 0 & 0 & 0 & 0 & 133.333 \\ 50 & 0 & 0 & 0 & 0 & 41.667 \end{bmatrix} \end{array} \qquad (\mathbf{PPRE}87)/(10)$$

Final 1987 reallocation matrix **PFIN**87(i,j)=(**PPRE**87(i,j)/(**PPRE**87(i,)***i**))*100 (rowsum≡100) (**i**: unit vector of dimension 6×1):

$$\begin{array}{c} \\ \text{NANO} \end{array} \begin{array}{c} \text{NA130} \\ \begin{bmatrix} 0 & 8.276 & 19.655 & 6.552 & 65.517 & 0 \\ 0 & 0 & 0 & 0 & 0 & 100 \\ 54.545 & 0 & 0 & 0 & 0 & 45.455 \end{bmatrix} \end{array} \qquad (\mathbf{PFIN}87)/(11)$$

The 1987 subtraction matrix based on **N** (4) and **O**87 (8):

$$\begin{array}{c} \\ \text{NANO} \end{array} \begin{array}{c} \text{NA130} \\ \begin{bmatrix} -66.667 & 0 & 0 & 0 & 0 & -100 \\ 0 & 0 & 0 & 0 & -66.667 & 0 \\ 0 & -10 & -30 & -10 & -41.667 & 0 \end{bmatrix} \end{array} \qquad (12)$$

Subtraction at NANO-level:

$$\begin{array}{c} \\ \text{NANO} \end{array} \begin{array}{c} \text{NA130} \\ \begin{bmatrix} -166.667 \\ -66.667 \\ -91.667 \end{bmatrix} \end{array} \qquad (13)$$

Subtracted values at NANO-level (13) reallocated using **PFIN**87 (11):

$$\begin{array}{c} \\ \text{NANO} \end{array} \begin{array}{c} \text{NA130} \\ \begin{bmatrix} 0 & 13.793 & 32.759 & 10.920 & 109.195 & 0 \\ 0 & 0 & 0 & 0 & 0 & 66.667 \\ 50 & 0 & 0 & 0 & 0 & 41.667 \end{bmatrix} \end{array} \qquad (14)$$

Finally (8), (12) and (14) are added to get the industry-converted NANO-NA130 matrix:

$$\begin{array}{c} \\ \text{NANO} \end{array} \begin{array}{c} \text{NA130} \\ \begin{bmatrix} 133.333 & 253.793 & 202.759 & 100.920 & 209.195 & 0 \\ 50 & 90 & 190 & 270 & 133.333 & 266.667 \\ 150 & 110 & 80 & 260 & 208.333 & 291.667 \end{bmatrix} \end{array} \qquad (15)$$

The conversion approximates the use of the underlying - *but not known* - conversion key at NANO-level.

The results of the year-specific conversions are then used to form conversion-keys at industry level based on the 1988 conversion key at industry level on matrix form:

$$\begin{array}{c} \\ NA130 \end{array} \begin{array}{c} NA117 \\ \left[\begin{array}{c} \\ \\ \\ \end{array}\right] \end{array} \qquad (16)$$

Row specific factors are multiplied on (16) to achieve the column sums from (15) where after column specific factors are multiplied to achieve column sums of one. This is repeated until convergence of the matrix is acceptable.

Finally, to eliminate transition problems between 1987 and 1988, the conversion-key of 1987 is made equal to the conversion-key of 1988 and differences are being smoothed over the period 1966 to 1986.

Appendix B

The following example of industry-conversion of intermediate consumption builds on the example from appendix A.

Table B.1 1988 output and intermediate consumption at NA130-level

	NA130nr1	NA130nr2	NA130nr3	NA130nr4	NA130nr5	NA130nr6
Output	300	400	470	630	550	550
Input	250	350	310	290	10	90
Input-percent	83.333	87.500	65.957	46.032	1.818	16.364

Table B.2 1987 output and intermediate consumption at NA117-level

	NA117nr1	NA117nr2	NA117nr3	NA117nr4
Output	700	500	700	1100
Input	400	300	400	100
Input-percent	57.143	60.000	57.143	9.091

Using 1988 intermediate consumption percentages at NA130-level (table B.1) and 1987 industry-converted output (conversion key identical to table A.1) a first estimate of 1987 intermediate consumption on combined NA117/NA130-level is calculated in table B.3.

Table B.3 1987 output and intermediate consumption (first estimate) on combined NA117/NA130-level

	NA117nr1 NA130nr1	NA117nr1 NA130nr2	NA117nr2 NA130nr2	NA117nr2 NA130nr3	NA117nr3 NA130nr3	NA117nr3 NA130nr4	NA117nr4 NA130nr5	NA117nr4 NA130nr6
Output	350.000	350.000	100.000	400.000	70.000	630.000	550.000	550.000
Input	291.667	306.250	87.500	263.828	46.170	290.002	10.000	90.000
Input-percent	83.333	87.500	87.500	65.957	65.957	46.032	1.818	16.364

For each NA117 industry, intermediate consumption is adjusted across NA130 industries to equal year-specific intermediate consumption ratios at NA117-level.

Table B.4 1987 output and intermediate consumption (adjusted at NA117-level) on combined NA117/NA130-level

	NA117nr1 NA130nr1	NA117nr1 NA130nr2	NA117nr2 NA130nr2	NA117nr2 NA130nr3	NA117nr3 NA130nr3	NA117nr3 NA130nr4	NA117nr4 NA130nr5	NA117nr4 NA130nr6
Output	350.000	350.000	100.000	400.000	70.000	630.000	550.000	550.000
Input	195.122	204.878	74.717	225.284	54.936	345.064	10.000	90.000

Table B.5 1987 output and intermediate consumption (adjusted at NA117-level) at NA130-level

	NA130nr 1	NA130nr 2	NA130nr 3	NA130nr 4	NA130nr 5	NA130nr 6
Output	350.000	450.000	470.000	630.000	550.000	550.000
Input	195.122	279.594	280.220	345.064	10.000	90.000

The year-specific intermediate consumption conversion keys are calculated directly based on table B.2 and B.4. As was the case for output, to eliminate transition problems between 1987 and 1988, the conversion-key of 1987 is made equal to the conversion-key of 1988 and differences are being smoothed over the period 1966 to 1986.

Appendix C

Table C.1 Effects of the individual definitional changes on GDP

	Cultivated natural growth	Military equipment	Entertainment, literary and artistic originals	Consumption of fixed capital on roads, bridges etc.	Financial leasing	Value threshold for capital goods	Software	Mineral exploration	Government licences and fees	Garages	Licences on intangible non - produced assets	Own production	Market / non-market	Insurance	Total
1987	0.02	0.05	0.08	0.78	0.00	-0.15	0.71	0.10	-0.15	0.22	-0.03	0.04	0.00	0.11	1.78
1986	0.03	0.05	0.08	0.75	-0.01	-0.16	0.58	0.08	-0.15	0.21	-0.01	0.05	0.00	0.10	1.60
1985	0.03	0.05	0.09	0.82	0.00	-0.16	0.47	0.11	-0.16	0.21	0.05	0.04	-0.01	0.12	1.65
1984	0.02	0.05	0.08	0.85	0.00	-0.15	0.40	0.13	-0.12	0.22	-0.02	0.03	-0.01	0.13	1.60
1983	0.00	0.05	0.08	0.89	-0.01	-0.15	0.37	0.23	-0.11	0.22	0.00	0.03	-0.01	0.13	1.73
1982	-0.04	0.05	0.09	0.91	-0.01	-0.15	0.34	0.09	-0.12	0.24	0.05	0.04	-0.01	0.15	1.64
1981	0.01	0.05	0.08	0.92	0.00	-0.14	0.33	0.07	-0.11	0.26	0.07	0.04	-0.01	0.18	1.74
1980	0.00	0.05	0.07	0.86	0.00	-0.14	0.30	0.05	-0.11	0.26	0.02	0.04	-0.01	0.16	1.55
1979	0.00	0.05	0.07	0.79	0.00	-0.13	0.22	0.02	-0.11	0.25	0.01	0.04	-0.01	0.14	1.33
1978	0.00	0.05	0.08	0.77	0.00	-0.13	0.20	0.03	-0.11	0.25	0.04	0.04	-0.01	0.12	1.31
1977	0.01	0.05	0.08	0.74	0.00	-0.13	0.19	0.06	-0.11	0.24	0.04	0.05	-0.01	0.12	1.32
1976	0.01	0.05	0.08	0.70	0.00	-0.12	0.18	0.06	-0.11	0.23	0.04	0.05	-0.02	0.11	1.25
1975	0.01	0.05	0.08	0.72	0.00	-0.12	0.17	0.06	-0.12	0.22	0.05	0.05	-0.02	0.10	1.26
1974	0.01	0.05	0.08	0.66	0.00	-0.12	0.14	0.04	-0.11	0.20	0.05	0.04	-0.02	0.11	1.13
1973	0.01	0.05	0.07	0.58	0.00	-0.11	0.12	0.05	-0.10	0.18	0.04	0.04	-0.02	0.10	1.02
1972	0.01	0.05	0.08	0.58	0.00	-0.12	0.11	0.02	-0.08	0.17	0.02	0.04	-0.02	0.09	0.96
1971	0.01	0.05	0.08	0.58	0.00	-0.11	0.10	0.02	-0.08	0.17	0.05	0.05	-0.02	0.10	1.00
1970	-0.02	0.05	0.08	0.55	0.00	-0.12	0.09	0.02	-0.09	0.15	0.04	0.04	-0.02	0.09	0.88
1969	-0.02	0.05	0.07	0.52	0.00	-0.11	0.07	0.03	-0.09	0.13	0.05	0.04	-0.02	0.08	0.80
1968	-0.04	0.06	0.07	0.50	0.00	-0.11	0.06	0.08	-0.11	0.13	0.05	0.05	-0.02	0.09	0.81
1967	0.00	0.06	0.08	0.46	0.00	-0.11	0.05	0.06	-0.10	0.12	0.05	0.05	-0.01	0.08	0.78
1966	0.00	0.07	0.07	0.41	0.00	-0.11	0.04	0.05	-0.10	0.11	0.06	0.05	-0.01	0.08	0.72

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