Retropolating SUTs and IOTs after the 2021 National Accounts Benchmark Revision[1]

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Abstract. This report describes the sources and methods used to compile a detailed time series of supply and use tables (SUTs) and input-output tables (IOTs) for the Netherlands for the years 2010-2021, consistent with the 2021 benchmark revision of the National Accounts. The work builds on the aggregate post-revision time series and combines data from previous National Accounts revisions with the revised classifications and totals. The resulting series provides detailed tables in current prices (CP) and prices of the previous year (PYP), aligned with the revised framework and suitable for analytical use. The report explains the compilation of the SUTs, the derivation of the IOTs, the additional processing required for transmission to Eurostat, and the main strengths and limitations of the chosen retropolation approach.

Keywords: National Accounts; supply and use tables; input-output tables; benchmark revision; retropolation.

1. Introduction

1.1 Background

Following the 2021 benchmark revision of the National Accounts, revised input-output tables (IOTs) were initially available only from reporting year 2021 in current prices and from reporting year 2022 in prices of the previous year. IOTs for earlier years did exist, but they were still aligned with the pre-revision figures and were therefore not consistent with the 2021 benchmark revision framework (Statistics Netherlands, 2024a) (Statistics Netherlands, 2024b).

IOTs are important for analysis and research because they describe interdependencies between industries and the role of imports and exports. They can be used to analyse how consumption, investment and exports contribute to production across industries, both directly and through their supply chains. Consistent IOT time series are also important for international partners and datasets, such as the OECD ICIO or the Eurostat FIGARO datasets. In addition, the ESA transmission programme requires Member States to transmit supply, use and input-output tables, including five-yearly IOTs for reference years ending in 0 and 5 (Eurostat, 2014).

At Statistics Netherlands (CBS), IOTs are compiled from supply and use tables (SUTs). SUTs describe the supply of goods and services, through domestic output and imports, and the use of these products as intermediate consumption, final consumption expenditure, gross capital formation and exports. Because SUTs combine production, income and expenditure information in one framework, they are a key integration tool within the National Accounts (European Commission, 2013) (United Nations Statistics Division, 2018).

IOTs have a more model-based character. They show how output from industries, and imports, are absorbed by other industries and by final expenditure categories. The SUTs provide the product totals for supply and use; the inner structure of the IOT - including inter-industry deliveries, imports by user, exports by supplying industry and final uses by supplying industry - is then derived using the regular IOT methodology.

For the years before 2021, however, no detailed revised SUTs were available. Revised IOTs for these years therefore could not be compiled with the regular production method. Aggregate SUTs had been retropolated back to 1995, but this series is available only at a very aggregate level and is not sufficiently detailed to serve directly as the basis for detailed IOTs compiled with the current method. See the table below for an overview of the coverage and dimensions of the aggregate and detailed SUTs.

Table 1 – Coverage and dimensions of the aggregate and detailed SUIOT time series

	# INDUSTRIES	# COLUMNS	# PRODUCT GROUPS	# ROWS	PERIOD
INTERNAL AGGREGATE SUTS	66	105	20	35	1995-2021
INTERNAL DETAILED SUTS	140	215	588	634	2010-2021
PUBLISHED SUTS	80	92	92	105	2010-2021
INTERNAL DETAILED IOTS	134	209	233	X	2010-2021
PUBLISHED IOTS	80	93	X	93	2010-2021

Note: Total columns comprise industry columns and additional columns for final expenditure, income and auxiliary entries, such as margins. Total rows comprise product group rows and additional rows for items such as taxes and subsidies and merchanting.

1.2 Objective and structure of the report

The objective of the project is to make detailed SUTs and IOTs available for 2010-2021 that are consistent with the 2021 benchmark revision of the National Accounts and with the tables compiled for the years after 2021. This document describes the sources and methods used to derive detailed SUT time series from the aggregate SUTs. These SUTs were then used to compile IOTs.

The report is structured as follows. Chapter 2 describes the methodology for compiling the SUTs. The approach consists of a sequence of automated and partly manual steps, using the detailed pre-revision tables as the starting point and the aggregate post-revision SUTs as the anchor. Chapter 3 explains how the IOTs were derived from these SUTs, following the regular production process as closely as possible. Chapter 4 describes the additional processing required for transmission to Eurostat. Chapter 5 discusses the results, limitations and recommended interpretation of the series.

2. Supply and Use Tables

This chapter describes the methodology used to compile a consistent time series of supply and use tables (SUTs) for the period 2010-2021. The objective was to provide detailed SUTs that are aligned with the 2021 benchmark revision and can serve as the basis for detailed IOTs. These detailed SUTs and IOTs have been compiled and are publicly available (Statistics Netherlands, 2026).

The available source data originate from different National Accounts revisions and therefore do not link directly to each other. Differences in classifications, sources and methods had to be bridged. A stepwise approach was therefore developed in which SUTs from earlier revisions were converted to the 2021 revision classifications and then aligned with the aggregate post-revision SUT time series. The aggregate SUTs are the benchmark constraint: the detailed series must add up to these aggregate totals.

2.1 The aggregate SUT time series

The aggregate SUT time series from 1995 onwards is aligned with the 2021 benchmark revision. It is available at the level of the most important aggregate industry and product groups (see table 1 for an overview) and is consistent with the revised main aggregates of the National Accounts.

The aggregate SUTs were developed to carry the effects of the 2021 benchmark revision back through time. Revision differences were generally phased backwards to earlier benchmark years, while specific revision effects for which additional historical information was available were treated separately through time-series layers. This approach was designed to preserve the pre-revision economic development as much as possible while ensuring consistency with the revised 2021 level (Statistics Netherlands, 2024a).

Two conceptually different types of adjustments were distinguished. First, specific time-series layers were constructed for individual revision projects. These layers incorporate project-specific information on how a revision should be distributed over time. Depending on the project, this information may originate from dedicated source data, auxiliary time series or substantive knowledge about the affected transactions. Where appropriate, project-specific price developments were also used. Examples include adjustments related to particular institutional units, conceptual changes, methodological improvements and reclassifications.

These specific layers are particularly informative because they add information beyond the pre-revision series itself. They determine not only the size of the revision adjustment, but, where sufficient information is available, also its timing and development over the historical period.

Second, after all specific layers had been applied, a general backcasting procedure was used for the remaining difference between the revised 2021 benchmark and the adjusted pre-revision series. Unlike the project-specific layers, this procedure does not introduce new source information. Instead, the residual revision difference is phased backwards according to a standardised rule, while preserving the development of the original series as much as possible.

The main principles of the aggregate SUTs are:

- The time series covers the period 1995-2021.
- The level of 1995 remains unchanged in principle; the intervening years are adjusted.
- The size of the adjustment depends on the revision difference in 2021.
- For the general backcasting of residual revision differences, price developments were generally not revised; specific time-series layers could incorporate project-specific price information where available. Revision effects are therefore allocated to volume changes in the aggregate SUTs.
- Revision differences are gradually reduced when moving backwards in time, so that the economic picture is disturbed as little as possible.
- The earlier revision years 2015, 2010, 2001 and 1995 provide natural anchor points within the series.

For the residual revision differences remaining after the application of the specific time-series layers, a phased backcasting approach is applied. The relative revision difference is reduced towards zero when moving back in time. Small revision differences are phased out more quickly than large revision differences. When the revision difference is less than or equal to 4 per cent, the difference is reduced in five steps towards revision year 2015. For larger revision differences, the difference is reduced in ten steps towards revision year 2010. Table 1 illustrates this approach.

Table 2 – Aggregate SUTs backcasting approach, example

	PRE-REVISION	REVISION EFFECT	%	RECALIBRATION	POST-REVISION FIGURES
2015	4.600	0	0.00%	0	4.600
2016	4.800	0	0.50%	24	4.824
2017	5.000	0	1.00%	50	5.050
2018	5.200	0	1.50%	78	5.278
2019	5.400	0	2.00%	108	5.508
2020	2.600	0	2.50%	65	2.665
2021	3.400	100	3.00%	102	3.502

Note: Figures are illustrative. The revision effect in 2021 equals 102 / 3,400 × 100 = 3%. This percentage is reduced linearly to zero in 2015 and applied to the pre-revision figure for each year. For example, the adjustment for 2018 is 5,200 × 1.5% = 78.

2.2 The detailed SUT time series

The detailed SUTs provide a detailed breakdown of the aggregate SUTs for the period 2010-2021 in the classifications of the 2021 revision. They were designed to align fully with the aggregate SUTs. Wherever possible, the same principles, time-series layers and backcasting strategies were used as in the aggregate SUT time series.

Backward calculation following a benchmark revision can be organised in different ways. (Schoonhoven, den Bakker, de Boo, & van der Helm, 2008) distinguish between annual backward calculation and approaches based on benchmark years with interpolation. Annual backward calculation may range from recompiling each historical year from the underlying source data to more pragmatic approaches that retain the existing balanced pre-revision series and subsequently incorporate the effects of the new revision.

The approach used for the detailed SUTs is closest to the latter strategy. The existing detailed pre-revision SUTs are retained as the starting point and subsequently converted to the classifications of the 2021 revision and adjusted for the effects of successive benchmark revisions. The resulting tables are then aligned with the revised aggregate SUT time series and rebalanced. In this way, information contained in the original detailed series is preserved as far as possible, while consistency with the revised framework is imposed.

(Schoonhoven, den Bakker, de Boo, & van der Helm, 2008) also emphasise that the choice of backward-calculation method involves trade-offs between quality, timeliness, resources and level of detail. This is particularly relevant here, since the 2021-revision time series was initially constructed at the relatively aggregated A64 × P10+ level, whereas the objective of the present project is to reconstruct the substantially greater level of detail required for the SUTs and IOTs.

The main principles of the methodology are:

- The detailed SUTs are a lower-level breakdown of the aggregate SUT time series.
- The available detailed pre-revision SUTs form the starting point.
- The results align fully with the 2021 revision.
- All outputs are published according to the 2021 revision (internal) classifications.
- Price developments are not revised; revision effects are allocated to volume changes.
- Values at previous year's prices for revision years are derived from the price ratios in the corresponding pre-revision SUTs.
- The approach follows the methodology of the aggregate SUTs as closely as possible.
- The methodology is modular, so that each step can be validated separately.

Data from three different revisions were combined to develop the detailed SUTs. Table 2 gives an overview of the available building blocks. Although several revisions are combined, all series were compiled within ESA 2010 and the same industry classification (NACE Rev. 2). The differences between these revisions are therefore much smaller than they would be in a transition to a new accounting framework or a new industry classification.

Table 3 - Building blocks of the SUT time series

	2021R CP	2021R PYP	2015R CP	2015R PYP	2010R CP	2010R PYP
2010					X	
2011					X	X
2012					X	X
2013					X	X
2014					X	X
2015			X		X	X
2016			X	X		
2017			X	X		
2018			X	X		
2019			X	X		
2020			X	X		
2021	X		X	X		

Note: 2021R, 2015R and 2010R denote SUTs compiled on the basis of the respective benchmark revisions, with benchmark years 2021, 2015 and 2010. CP denotes current prices; PYP denotes previous year prices.

The estimation methodology for the detailed SUTs consists of three main phases:

1. Pre-processing: the pre-revision SUTs are converted to the 2021 revision classifications using an automated production process in R. Revision effects, values at previous year's prices and alignment with the aggregate SUTs are also prepared.

2. Automated balancing procedure: the pre-processed supply and use tables are fitted. The procedure resolves supply-use imbalances and simultaneously enforces accounting identities, economic restrictions and alignment with the aggregate SUTs.

3. Post-processing: a limited number of targeted corrections is made, including corrections related to foreign trade restrictions, valuation items and the derivation of input-output tables.

These steps are explained in more detail in the following subsections.

2.2.1 Pre-processing

Pre-processing consists of automated steps that prepare the pre-revision SUTs for the automated balancing procedure. The aim is to bring the pre-revision data as close as possible to the 2021 revision structure and to process the main revision effects before fitting.

Pre-processing consists of the following components:

- conversion to the 2021R (internal) classification of columns and rows;
- addition of values at previous year's prices for revision years;
- conversion of aggregate SUT time-series layers to the detailed level;
- the phased backcasting approach;
- balancing by SUT column on net operating surplus and mixed income;

- benchmarking to the aggregate SUTs.

Conversion to the 2021R classification

The first step is to convert current-price and previous-year-price information from the pre-revision SUTs to the 2021 revision classification. For the 2015 revision SUTs, covering the years 2015-2021, one bridge table is needed: from 2015R to 2021R. For the 2010 revision SUTs, covering the years 2010-2015, two links are needed: first from 2010R to 2015R and then from 2015R to 2021R.

For each column or row in the SUT compilation framework (see Table 1 and its note), five possible situations can be distinguished:

1. Unchanged: The SUT column or product group exists in both classifications. This applies to most SUT columns and product groups.
2. Split: a SUT column or product group in the old classification is split into several SUT columns or product groups in the new classification. An example is the introduction of production-abroad SUT columns for imports and exports. These transactions were included in the regular import and export SUT columns in the old classification, but were made separately visible in 2021R.
3. Merged: Several SUT columns or product groups in the old classification are merged in the new classification. An example is the SUT column for sheltered workplaces, which was merged with the SUT column for public administration.
4. Discontinued: A SUT column or product group from the old classification no longer occurs separately in the new classification. An example is the public transport subsidy.
5. New: A SUT column or product group occurs in the new classification but not yet in the old classification. Examples are the SUT column for directors-major shareholders and the product group for packaging tax. These new combinations are added in a later step on the basis of the layer information from the aggregate SUTs.

Allocation keys are required for splits. For the transition from 2015R to 2021R, the distribution was calculated for each SUT cell on the basis of current-price values in 2021R. For the transition from 2010R to 2015R, weighting factors were taken from the bridge table underlying the 2015 revision.

The new classification was applied retrospectively to the full time series. For splits, however, no attempt was made to reconstruct year-specific historical allocation shares. Instead, a fixed allocation key was used over time. For the transition from 2015R to 2021R, this key was based on the current-price distribution observed in 2021R. Consequently, the relative distribution between the newly distinguished categories is held constant before 2021, unless additional information was introduced in a later processing step. This approach preserves the 2021 classification throughout the series, but does not capture possible changes over time in the composition of split categories.

Classification conversion of SUTs and IOTs can range from straightforward one-to-one recoding or aggregation to cases in which an old category has to be distributed across several new categories. The latter require additional information or assumptions to determine the allocation. (Rueda-Cantuche, Amores, & Remond-Tiedrez, 2020) show that conversions based only on aggregate information may introduce substantial uncertainty and they emphasise the advantages of using detailed source information and well-founded bridge matrices where these are available. The relatively detailed information available within Statistics Netherlands was therefore important for the classification conversion applied in this project.

Figures 1 and 2 give an overview of the links for SUT columns and product groups, respectively.

Figure 1 - Overview of classification links for SUT columns between revisions

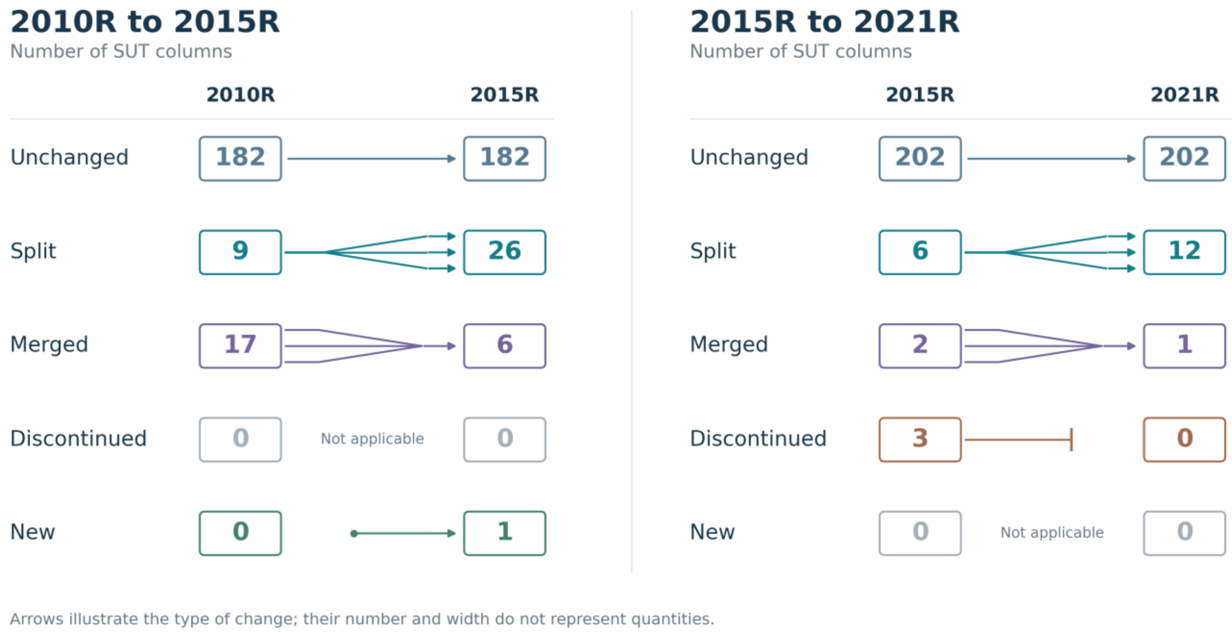
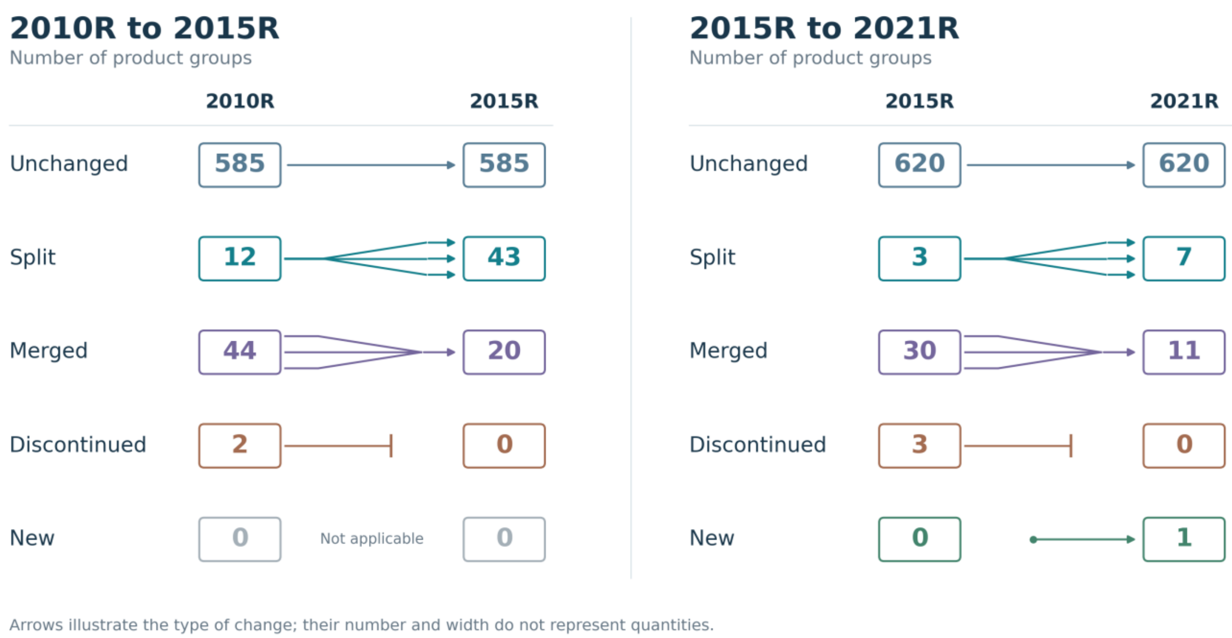


Figure 2 - Overview of classification links for product groups between revisions



For most SUT columns and product groups, the classification is unchanged. The greatest uncertainty arises in the case of splits, because assumptions are needed to allocate old values to new categories. This is a general issue in classification conversion: whereas one-to-one mappings and aggregations can generally be implemented directly, disaggregation requires additional information or allocation assumptions (Rueda-Cantuche, Amores, & Remond-Tiedrez, 2020).

This applies, for example, to production abroad. In the pre-revision figures, production-abroad transactions were present in the underlying calculations but not visible as separate SUT columns. An attempt was made to enrich the post-revision production-abroad SUT columns with this underlying information, but differences in sources and methods proved to be too large. In practice, the years before the revision were therefore largely aligned with the ratio observed in the revision year.

Addition of values at previous year's prices for revision years

In the building blocks used for this project, data from the revision years are available only in current prices. Values at previous year's prices for those revision years therefore had to be derived in a separate step. This was done using the PYP/CP ratio from the pre-revision figures for the relevant revision year. This approach follows the project principle that price developments are not revised. Revision differences are therefore, in principle, allocated to volume developments.

There are several exceptions:

1. Small amounts: if the value in current prices in the revision year is less than or equal to EUR 10 million, the specific PYP/CP ratio of the detailed SUT cell is not used. Instead, the PYP/CP ratio of the total product group is used. This prevents small or unstable cells from being assigned implausible price developments.

2. New product group-SUT cell: For new combinations, no price ratio is available from the pre-revision year. In this case too, the PYP/CP ratio of the total product group is used.

3. Entirely new product group: If the product group as a whole is new, the value at previous year's prices is set equal to the value in current prices. In that case, no usable historical price ratio is available.

4. Net operating surplus and mixed income ('other income'): for other income, the value at previous year's prices is derived as a balancing item, so that pre-processing remains balanced by SUT column. The PYP value of other income is calculated as total supply minus total use minus value added excluding other income.

Conversion of aggregate SUTs layers to the detailed level

Time-series layers were used in the aggregate SUT compilation to process the specific impact of revision projects over time. These layers may relate to company-specific revisions, but also to conceptual or methodological changes, such as the estimation of margins on trading financial assets (spreads) or illegal activities. Because the specific time-series layers contain information that is not captured by the general backcasting procedure, retaining this information was an important objective when constructing the detailed SUT series.

For the 2021 revision, these layers were compiled at the aggregate level: A64 industries and P10+ product groups. For the detailed SUTs, they had to be allocated to the detailed level of the 2021 revision classification. In some cases, this allocation could be derived from underlying source data. In many cases, the impact of a layer was sufficiently isolated to relate it to one or a few SUT columns and product groups. A limited number of layers could not be fully allocated, but for the great majority the allocation was successful. Some layers run back to before 2015. Errors were also found in a few older layers. These layers were nevertheless included in the detailed SUTs, because alignment with the aggregate SUTs was the overriding requirement. Without them, the detailed SUTs would not add up to the aggregate SUTs.

For the 2015 revision, the conversion was simpler. The time-series layers from that revision had largely already been compiled at a more detailed level, so the link to the detailed SUTs required less processing.

The phased backcasting approach

As in the aggregate SUTs, revision differences in the detailed SUTs are not placed abruptly in the revision year. Large revision differences are carried back through time using a phased backcasting approach. This approach distributes revision differences gradually over earlier years and ensures that the series links to the previous revision year. Under the relatively linear backcasting approach used here, the relative revision difference is reduced linearly to zero. The aim is to preserve the original pre-revision developments as much as possible.

The general backcasting procedure necessarily affects both levels and year-on-year growth rates, because the relative adjustment changes gradually over time. These effects cannot be eliminated if the series is to connect both to the earlier revision and to the new benchmark level. Instead, the method is designed to limit such effects by applying specific time-series layers first, using the general backcasting procedure only for the remaining revision difference, and spreading larger adjustments over a longer period. In this way, changes in growth rates are distributed gradually over time rather than concentrated around the benchmark year.

In the aggregate SUTs, large revision differences are carried back to 2010 and small revision differences to 2015. This approach was followed as closely as possible in constructing the detailed SUTs. In addition, a general backcasting adjustment is applied to detailed SUT cells with a revision difference of more than EUR 50 million in revision year 2021. This revision difference is determined after correction for the layers already added in the preceding step.

There are two exceptions:

1. New cells in 2021R with a value of more than EUR 50 million: for new combinations, no historical development is known. In such cases, the amount is carried backwards linearly in absolute terms. This means that an absolute amount, rather than a relative percentage, is gradually phased back through time.

2. Cells with a revision difference of more than EUR 50 million and a growth rate of more than 200 per cent: for very large relative revision changes, the chosen backcasting method can strongly influence the path of the time series. To avoid unrealistic developments, these cases are also carried backwards linearly in absolute terms.

The length of the backcasting path is determined by the revision difference of the corresponding aggregate SUT cell. If the difference is greater than 4 per cent, backcasting continues to 2010. If the difference is less than or equal to 4 per cent, the revision difference is carried backwards in six steps to 2015.

Balancing by SUT column on net operating surplus and mixed income

After the preceding steps, a difference may still arise within a SUT column between the components of value added. To balance pre-processing by SUT column, net operating surplus and mixed income ('other income') are used as the balancing item. For both current prices and prices of the previous year, other income is calculated as total supply minus total use minus value added excluding other income.

This step is intended to keep the relationship between output, intermediate consumption and value added at SUT-column level consistent before the data are supplied to the automated balancing procedure. This prevents the automated balancing procedure from also having to resolve differences that originate in the internal construction of the pre-processing.

Benchmarking to the aggregate SUTs

After classification conversion, the addition of layers and the phased backcasting, differences may still remain between the detailed and aggregate SUTs. Because the aggregate SUTs are the anchor, an additional realignment is carried out at this stage.

The remaining difference at aggregate SUT level is allocated to the underlying cells. The allocation is based on the structure of the revision year, because that detailed structure provides the best available information on the distribution of the aggregate across the underlying combinations.

Table 3 gives a simplified example. Panel A shows the pre-revision figures for an aggregate and three underlying detailed series. Panel B shows the realignment. For 2021, the distribution across the detailed series is known; for earlier years, only the difference at aggregate level is available. The distribution in earlier years is therefore derived from the structure of the revision in 2021. Panel C shows the resulting post-revision figures.

Table 4 - Recalibration to the aggregate SUTs, example

	2015	2016	2017	2018	2019	2020	2021
A: PRE-REVISION FIGURES							
AGGREGATE SUT	800	890	980	1.070	1.160	1.050	1.300
DETAILED SUT 1	500	600	700	800	900	800	1.000
DETAILED SUT 2	300	290	280	270	260	250	300
DETAILED SUT 3	0	0	0	0	0	0	0
B: REVISION							
AGGREGATE SUT	0	50	100	150	200	250	300
DETAILED SUT 1	0	30	60	90	120	150	180
DETAILED SUT 2	0	13	27	40	53	67	80
DETAILED SUT 3	0	7	13	20	27	33	40
C: POST-REVISION FIGURES							
AGGREGATE SUT	800	940	1.080	1.220	1.360	1.300	1.600
DETAILED SUT 1	500	630	760	890	1.020	950	1.180
DETAILED SUT 2	300	303	307	310	313	317	380
DETAILED SUT 3	0	7	13	20	27	33	40

Note: For 2016–2020, the aggregate revision in panel B is allocated to the detailed SUT components using their shares in the total revision in 2021: 180/300, 80/300 and 40/300, respectively. For example, the 2017 revision for Detailed SUT 2 is calculated as 100 × (80/300) = 26.67, rounded to 27. All amounts are rounded to whole numbers.

This method works well as long as the distribution across detailed combinations remains economically plausible. This is not always the case. If positive and negative factors offset each other, the recalibration can lead to negative values. For most product groups within supply and use blocks, such negative values are not warranted. In these cases, the realignment is not carried out in pre-processing and the remaining difference is left to the automated balancing procedure. This occurs in about 10 to 15 per cent of SUT cells.

For the realignment, the level of the aggregate SUTs is leading. In principle, the detailed series must therefore add up to the aggregate data, even when the aggregate data contain imperfections. The method has limitations. It works less well for combinations for which many positive and negative adjustments were made during the 2021 revision. This problem is amplified when earlier years show divergent developments or when one aggregate SUT cell contains many heterogeneous underlying cells. One example is the aggregate SUT product group for manufactured products, which contains more than 190 product groups from the detailed 2021R classification.

For approximately 15 per cent of aggregate SUT cells, recalibration is therefore not carried out in pre-processing. These are cells for which an economically implausible outcome would arise for at least one underlying detailed cell.

For these cells, the recalibration component is disabled. The pre-processing for these combinations is then not yet fully consistent with the aggregate SUT; the remaining differences are resolved in the automated balancing procedure.

2.2.2 Automated balancing procedure

The pre-processing results in detailed supply and use tables that are close to the structure of the 2021 revision, but are not yet fully balanced or fully aligned with the aggregate SUTs. The remaining differences are resolved using an automated balancing procedure configured for this project. Before applying the procedure, a small number of evident imperfections were corrected manually. These mainly concerned production-abroad SUT columns for products within CPA 26, including transmission apparatus.

The procedure combines standard SUT accounting identities, as described in (Eurostat, 2008) and (United Nations Statistics Division, 2018), with alignment requirements and mathematical bounds configured specifically for this project:

- Alignment with the aggregate SUTs: for every combination distinguished in the aggregate SUT time series, the detailed cells must sum to the corresponding aggregate total.
- Supply equals use: for each product group, total supply must equal total use.
- Output identity: for each SUT column, output must equal intermediate consumption plus value added (at basic prices). The associated identities for margins, transit trade and the cif/fob adjustment are also enforced.
- Mathematical bounds: variables generally have a lower bound of zero. Subsidies are instead subject to an upper bound. No bounds are imposed on FISIM, changes in inventories, valuables and technical dummy items or balancing items.[3]

No further constraints or weighting refinements were introduced, because the mandatory alignment with the aggregate SUTs already leaves limited scope for adjustment. Each year and each price basis—current prices and prices of the previous year—is processed independently. The procedure therefore contains no year-to-year constraints and no constraints linking the two price bases. Adding another year consequently has no effect on the results for the other years.

2.2.3 Post-processing

After application of the automated balancing procedure, a limited post-processing phase was carried out. This phase is needed because not all economic plausibility rules can be included in the automated balancing procedure fully or efficiently. Some checks require substantive assessment or are linked to the derivation of input-output tables.

Post-processing largely consists of corrections that are also applied in the regular production cycle for supply and use tables. This applies, for example, to foreign trade, where consistency is enforced between different SUT columns for the same product group. For each product group, output may not be lower than exports of domestic product, and imports may not be lower than re-exports. Where such relationships were not yet plausible after application of the automated balancing procedure, they were corrected in post-processing.

In addition, supply and use of valuation items were manually adjusted in a few cases. One example concerns retail trade margins. The supply of retail trade margins on a good may not exceed the use to which that margin can relate.

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[3] Balancing items are calculated as the difference between other accounting items and may take either positive or negative values. Examples include net operating surplus (B2N) and net mixed income (B3N), which represent the income remaining from production after deducting intermediate consumption, compensation of employees, other taxes less subsidies on production, and consumption of fixed capital from output.

If final consumption expenditure is the only user of a particular margin, this consumption therefore forms an economic upper bound for the supply of that margin.

Part of this post-processing was carried out in conjunction with the derivation of the input-output tables. The IOT derivation can reveal additional inconsistencies or implausible patterns that are less directly visible in the SUTs themselves. The methodology for deriving the input-output tables is discussed in the next chapter.

3. Input-Output Tables

The detailed input-output tables were compiled as far as possible according to the regular procedure. In this procedure, IOTs are derived from the SUTs. As a result, accounting consistency between the SUTs and IOTs is maintained throughout the series: the IOTs are constrained by the supply and use totals of the corresponding SUTs. Earlier benchmark IOT structures are used as supporting information where relevant, but are not imposed unchanged on the retropolated series. This chapter first describes the regular derivation and then explains where the compilation of the detailed time series deviates from that standard procedure.

3.1 Regular procedure

The derivation of input-output tables from SUTs broadly consists of two steps. First, the use table is converted to the same valuation as the supply table (basic prices). Second, supply items are linked to use items. This ultimately leads to an industry-by-industry table showing which industries and import categories supply to which other industries and final expenditure categories.

3.1.1 Derivation of valuation matrices

The first step is the conversion of the use table to basic prices. In the Dutch SUTs, the use table is compiled at purchasers' prices with VAT handled separately. For the IOT derivation, the relevant use values are converted to basic prices, consistent with the valuation of the supply table. Product-related taxes and subsidies, trade margins and transport margins are therefore determined for each product group and deducted from the relevant use items (European Commission, 2013) (Eurostat, 2008) (United Nations Statistics Division, 2018).

In the calculation of valuation adjustment rates, the amount to be distributed for most product groups is allocated across the relevant use columns in proportion to purchases in the SUTs. If a SUT column accounts for 10 per cent of purchases of a particular product group, then in principle 10 per cent of the relevant valuation item is allocated to that SUT column.

The permitted users differ by valuation item. As a result, the distribution across SUT columns also differs by type of valuation item. Retail trade margins, for example, can be allocated only to consumption through retail trade (P31A1) and a limited number of other SUT columns. Wholesale trade margins on exports can be allocated only to export SUT columns.

For a limited number of product groups, the distribution of valuation items does not use the current year SUT structure but the structure of the preceding year. This concerns natural gas, distilled alcohol, hot water and district heating, water and electricity. For these product groups, valuation items are not always distributed proportionally across users. An example is the regulatory energy tax: the effective tax rate decreases as electricity or gas use increases. In such cases, a distribution in proportion to purchases would not produce a plausible result. Once a plausible distribution has been established in a revision year, this structure can be extrapolated in subsequent years using the structure of T-1.

3.1.2 Derivation of the source-use transaction matrix

The second step is the derivation of the source-use transaction matrix for domestic output and imports. In this step, supply items are linked to use items. The transformation is carried out at detailed product-group level, distinguishing approximately 280 product groups and 130 industries. The result is an industry-by-industry table. Imports are treated in parallel with domestic supply, so imports of goods and services are also allocated to the industries and final expenditure categories that use them.

This step uses a variant of the fixed product sales structure model (Model D in (Eurostat, 2008)). Under this assumption, each product has its own sales structure, independent of the industry that produces the product. The destination of a product is therefore primarily determined by the nature of the product, not by the industry that produces it. If a product is supplied by several industries, the same sales structure for that product is in principle applied to those industries.

The consequence is that the distribution across users is determined by product group. For a given product group, the first step is to determine where total supply of that product group is used: in intermediate consumption by industries, final consumption expenditure, gross fixed capital formation, exports or other final expenditure. This use structure is then linked to the industries and import items that supply the product group. An industry producing a particular product is therefore assigned the sales structure associated with that product.

This has important implications for the distributions in the input-output table. Products mainly used as intermediate consumption are allocated primarily to industries as users. Products mainly consumed by households are allocated primarily to final consumption expenditure. Products mainly exported receive a relatively strong link with exports. Because the transformation is carried out at detailed product-group level, differences in sales structure are already captured to a large extent by the product classification itself.

As a result, an industry in the input-output table does not automatically supply to all possible categories of use. Its sales are determined by the products it produces and by the sales structure of those products. An industry that mainly produces intermediate services for the domestic market, such as employment services, is therefore not automatically linked to exports or final consumption expenditure if there is no appropriate product or sales structure. Conversely, an industry producing products that are exported to a significant extent will be linked more strongly to exports through the product structure.

The structure from the revision year forms the starting point for subsequent reporting years. In compiling the IOT for a revision year, extensive use is made of autonomous information. This is consistent with the recommendation to supplement the fixed product sales structure assumption with observed information on inter-industry flows wherever such information is available (Eurostat, 2008). For example, detailed international merchandise trade statistics can be used to establish explicit relationships between imported products and using industries, and between exported products and producing industries. Industry-specific information is also used, for example on industries that supply substantially to other industries and on producer-user combinations that hardly occur, if at all, in practice.

Once this basic structure has been established, supply is distributed by product group across using industries and final expenditure categories. This distribution takes account of the observed use structure, autonomous information and predefined restrictions on possible producer-user combinations. The table is then made consistent with the product-group totals from the SUTs using an optimisation method. For non-revision years, the structure of the preceding reporting year is the starting point. New autonomous information is added where available. Where no new information is available, the previous year's distribution of supply across using industries and final expenditure categories is retained as far as possible for each product group.

3.1.3 VAT and travel

For the IOTs, several breakdowns are needed that are not directly available in the SUTs. This includes the distribution of value added taxes (VAT) across product groups and the allocation of travel-related consumption expenditure of non-residents in the Netherlands.

The SUTs are compiled excluding VAT, with VAT available separately by SUT column when the SUTs are finalised. For the IOT, however, VAT must also be distributed across the product groups to which it relates. A similar issue arises for consumption expenditure of non-residents in the Netherlands. This expenditure is included in the SUTs as a separate SUT column (P622), but must be further distributed across product groups for the IOT.

In regular production, these distributions are produced afterwards by the relevant specialists.

3.2 Deviations from the regular procedure to compile IOTs

3.2.1 Derivation of valuation matrices

For this project, the regular method for deriving valuation matrices was applied as far as possible. For most product groups, valuation items were therefore distributed using the current SUT structure and the applicable allocation rules for each type of valuation item.

For the five product groups for which the T-1 structure is normally used, this project used the structure of T+1 instead. These product groups are natural gas, distilled alcohol, hot water and district heating, water and electricity. The deviation follows from the direction in which the IOTs were compiled. In regular production, the years after a revision year are compiled using the structure from the preceding year. In this project, by contrast, the IOTs are calculated backwards from reporting year 2021. Therefore, for these product groups the structure of the next year rather than the preceding year serves as the starting point.

3.2.2 Derivation of the source-use transaction matrix

In the regular procedure, the structure from the revision year also forms the starting point for subsequent reporting years in the source-use transaction matrix. The same logic was followed in this project, but in reverse. Because the series is calculated backwards from reporting year 2021, the structure of T+1 was used instead of the structure of T-1.

In some cases, this structure was enriched with information from the pre-revision source-use transaction matrix. This was done, for example, for the years 2020 and 2014. Viewed from the backward calculation starting in reporting year 2021, these years are located directly at revision transitions. They were therefore also the years in which potential breaks in the structure became visible first. By supplementing the new structure with information from the pre-revision tables, more plausible detailed distributions could be obtained.

3.2.3 VAT and travel

For this project, a simplified method was applied: distributions from the pre-revision tables were applied to the new totals from the detailed SUTs.

For the distribution of VAT across product groups, the distribution from revision year 2015 was used for the years 2010-2014. This choice reflects a change in the treatment of VAT in the IOTs. Up to and including 2014, the IOTs recorded theoretical VAT, while the VAT gap (that is, the difference with the actually collected VAT) was shown separately. From 2015 onwards, the IOTs instead record VAT as actually collected/recorded. The pre-2015 VAT distributions are therefore not directly comparable with those from 2015 onwards. For this reason, the pre-revision distributions for 2010-2014 were not used directly; instead, the distribution from 2015 was applied to the new VAT totals for those years.

3.2.4 Adjustments in the SUTs following the IOT derivation

In the regular production cycle, SUTs rarely have to be adjusted in order to obtain a balanced IOT. In this project, such adjustments were needed more often than usual. In most cases, however, the amounts involved were not substantial.

This is related to the way in which the SUTs in this project were produced. They were compiled largely automatically and also had to align with existing totals and structures from earlier series. This could lead to implausible values at the detailed level. Sometimes this was the result of automatic processing. In other cases, it was caused by the need to align with aggregate SUT values that were not plausible at the detailed level. Where such values caused bottlenecks in compiling the IOTs, targeted adjustments were made in the SUTs.

4. Transmission to Eurostat

Several additional processing steps are required for the transmission of SUTs and IOTs to Eurostat. These steps are partly methodological, such as the allocation of trade and transport margins across industries, and partly related to the industry and product classifications required under the ESA transmission programme.

4.1 Overview

For the transmission of SUTs and IOTs to Eurostat, several additional processing steps are needed relative to the Dutch tables. A general difference concerns the level of aggregation. The mandatory Eurostat tables distinguish 64 activities and 64 products, based on NACE Rev. 2 and CPA, respectively. The Dutch tables contain more detail in some areas and therefore have to be aggregated to the required level for Eurostat transmission (Eurostat, 2014).

Part of the difference between the Dutch tables and the Eurostat tables concerns the presentation of items. Taxes and subsidies on products, for example, are shown separately in the Dutch tables, whereas Eurostat generally requests taxes less subsidies on products. The Eurostat use table also contains additional rows for operating surplus and mixed income that are not separately included in the Dutch use table. In principle, these differences require reclassification and presentation changes rather than new source estimates.

Other differences require additional processing. This applies first to international trade. In the Dutch supply table, imports are distinguished between goods and services. In the Eurostat supply table, imports are broken down by area of origin: intra-EU within the euro area, intra-EU outside the euro area and extra-EU. A similar difference occurs on the export side of the use table and IOT. The Dutch tables distinguish, among other things, exports from domestic output, re-exports and exports of services, whereas Eurostat classifies exports by destination. These breakdowns by origin and destination are not directly available in the SUTs and therefore have to be added afterwards.

The consumption expenditure of residents abroad is also treated differently. In the Dutch use table, this item is visible separately, whereas in the Eurostat tables it is not presented in the same way as a separate column. For Eurostat transmission, this item must therefore be processed in line with the Eurostat classification of final expenditure and international trade.

The most important or consequential difference concerns trade and transport margins. In the Dutch tables, trade and transport margins are visible through separate rows and columns. For Eurostat, these margins must be allocated to the transactions in the body of the table. Margins are therefore distributed according to the purchasing and selling industries and product groups to which they relate.

4.2 Method used in this project

For the required breakdowns, such as those for international trade, imports by government, business travel, merchanting margins and margins on second-hand goods, distributions from the pre-revision tables were used as much as possible. These distributions were applied to the new totals from the detailed SUTs.

For mixed income, time-series data aligned with the revision for reporting year 2021 were used. These data are added for the Eurostat use table, in which mixed income is shown separately within the value added block.

For the allocation of trade and transport margins, the regular calculation method was followed. Margins are allocated according to the purchasing and selling industries and product groups to which they relate. Where substantive information is available, it is used to steer the allocation. For the remaining part, a general allocation method is applied. A solver then ensures that the distributed margins are consistent with the totals of the table.

5. Results and discussion

5.1 Results

The main result of the project is a detailed time series of SUTs and IOTs for 2010-2021 that is consistent with the revision for reporting year 2021 and with the tables compiled for later years. This makes it possible to carry out analyses over a longer period using a single coherent system of tables. This is important, among other things, for comparisons between the periods before, during and after the COVID-19 pandemic and for analyses of structural developments over multiple years.

The new series can be used directly for publications and research projects within Statistics Netherlands. This applies particularly to applications by the Environmental Accounts team and the internal research team, where the tables are used for value-chain analyses, environmental-economic analyses and other applications in which the relationships between output, imports, exports, final expenditure and value added are central.

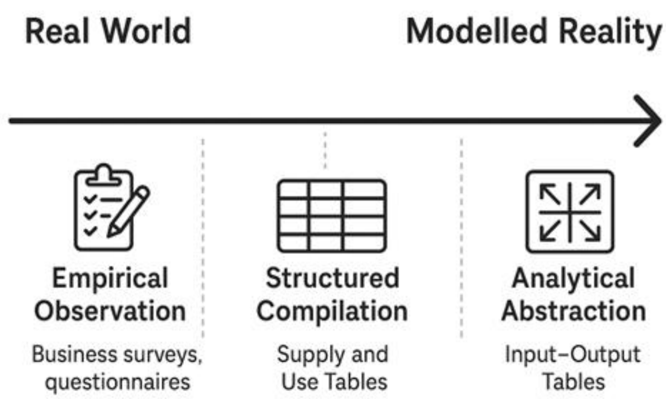
The project also produced a working method that can be used in future benchmark revisions. The approach is largely automated and built up from separate steps. After each step, the results were assessed in a targeted way, so that deviations or undesired outcomes could be identified in time and adjusted where necessary. Although some imperfections remain in the final series, the working method proved successful overall.

An additional result is that the work could be carried out by a relatively small group of specialists from several teams within the National Accounts division. The combination of automation, targeted checks and substantive assessment made it possible to carry out a complex and extensive project in a manageable way. The project has therefore not only made a new time series available, but also generated experience with an approach that can be applied again in comparable projects.

5.2 Strengths and weaknesses

5.2.1 From source statistics to modelled reality

To interpret the strengths and weaknesses of the SUTs and IOTs resulting from this project, it is useful to consider the path from source statistics to input-output tables. A distinction can be made between observations that are relatively close to actual economic reality and tables that provide a more modelled representation of that reality. The figure below shows this schematically.



Source statistics, such as surveys, administrative records and other empirical observations, are closest to the observed economy. They provide information on concrete transactions, output, costs, turnover, imports, exports or other economic variables. However, these sources are not complete, do not always align precisely with each other, and are often compiled from the perspective of individual statistics.

The SUTs are a first step towards a coherent macroeconomic picture. On the basis of the available source information, output, imports, intermediate consumption, final expenditure and value added are brought together in one integrated system. Missing elements are added, inconsistencies between sources are resolved, and estimates are aligned with each other. The SUTs therefore remain clearly connected with the underlying source statistics, but already contain model-based choices and accounting corrections. More generally, national accounts compilation combines source information with accounting identities, assumptions and plausibility checks in order to arrive at a complete and internally consistent representation of the economy (Bos, 2009).

The IOTs are a further abstraction. They are derived from the SUTs and describe deliveries between industries and to final expenditure. In practice, inter-industry deliveries in particular are not, or are only to a limited extent, directly observed. The IOT makes these relationships visible on the basis of assumptions, allocation models and transformations of the information from the SUTs. The table is therefore highly valuable analytically, but it is further removed from direct source observation than the SUTs (European Commission, 2013) (United Nations Statistics Division, 2018).

5.2.2 SUTs and IOTs derived in this project

Within this continuum, the detailed SUTs and IOTs from this project move somewhat further towards modelled reality. The series were not compiled directly from the original source statistics according to the complete regular estimation procedure. Instead, they were derived from existing SUT and IOT series. Older tables were adjusted to the outcomes and classifications of the 2021 revision. In some cases, values were scaled, allocated or otherwise adjusted to obtain alignment with the revised framework. This also applies to the IOTs, which were derived directly from the adjusted SUTs.

This does not make the series less useful, but it does require careful interpretation. The strength of the series lies primarily in its consistency over time and its alignment with the revised 2021 level. The series is therefore well suited to analyses of trends, structures and developments over a longer period. At the same time, individual cells, especially at detailed level, may be more strongly influenced by model-based choices than in regular annual series compiled directly from the full source statistics. When using such estimates, it is important to distinguish between information that is directly supported by observations and information that is largely determined by assumptions or compilation methods (Bos, 2007).

As described in the SUT chapter, this applies particularly to splits of product groups and SUT columns. One example is the introduction of production abroad as a breakdown of exports of domestic product. Such splits improve alignment with the revised framework, but at the detailed level they may also increase the model-based influence on individual cells.

5.2.3 Reliability by level of detail

For this reason, it is important to emphasise that data by product group and SUT column - for supply, intermediate consumption or value added - are not equally reliable at all levels of detail. This applies in particular at the level of more than 600 product groups, where small cells, new splits and shifts between items can have a relatively large influence.

At a more aggregated level, the results are generally more robust. The series have a smoother path and are better aligned with the trends from the pre-revision series, unless a deliberate adjustment was made through a time-series layer. Broadly speaking, this applies to the level of the SUT columns and product groups used to derive the IOTs, with approximately 280 product groups and 130 SUT columns. At the level of the published tables, with approximately 81 industries, the results are even more stable and more suitable for external analyses and publications.

5.2.4 Current prices and prices of the previous year

In compiling the SUTs and IOTs in this project, the main emphasis was on making current-price values plausible. Values at prices of the previous year were determined simultaneously, as in the regular process, but a somewhat greater degree of imperfection was accepted for these values. This was partly a pragmatic choice, because current-price tables are used most in many applications. It was also partly a consequence of the requirement to align with the aggregate SUTs.

A key methodological issue concerns the treatment of prices in the aggregate SUTs. Ideally, values at prices of the previous year would be derived from the underlying detailed series. In that case, the price developments of the individual detailed items are preserved and the aggregate value is determined as the sum of those underlying items. This is consistent with the general principles for price and volume measurement in national accounts, according to which price and volume measurement should start from a sufficiently detailed product breakdown and volume measures should subsequently be aggregated using previous-year weights (Eurostat, 2016). This is particularly important when components within an aggregate have strongly diverging price developments.

In the construction of the aggregate SUTs, however, a more pragmatic approach was chosen. The new values in current prices were combined with the aggregate price index from the pre-revision series. The underlying price indices of the detailed items were therefore not always reapplied individually. This choice was understandable given time constraints, but in specific cases it can lead to less plausible values at prices of the previous year.

This can be illustrated with a simple example. Suppose that an aggregate item B1 consists of two underlying items: B1.1 and B1.2. In the pre-revision series, the situation is as follows:

Item	Current prices	Previous year's prices	Price index
B1.1	1 000	600	166.7
B1.2	1 000	1 400	71.4
B1	2 000	2 000	100.0

At the aggregate level, B1 therefore has a price index of 100.0. Beneath this aggregate, however, two very different price developments are hidden: B1.1 has a price index of 166.7, while B1.2 has a price index of 71.4.

Now suppose that the revision only leads to a higher value in current prices for B1.1. The value of B1.1 increases from 1,000 to 1,500, while B1.2 remains unchanged. It would then be most logical to continue using the original price indices of the underlying items. The value at prices of the previous year for B1.1 would then be 900, and that for B1.2 would remain 1,400. The aggregate value of B1 at prices of the previous year would then equal 2,300:

Item	Current prices	Previous year's prices	Price index
B1.1	1 500	900	166.7
B1.2	1 000	1 400	71.4
B1	2 500	2 300	108.7

This would be the preferred outcome. The change in the composition of B1 is then reflected in the aggregate price index. Because the share of B1.1 increases, and B1.1 has a relatively high price index, the price index of aggregate B1 also increases.

In the construction of the aggregate SUTs, however, a different approach was followed. The new current-price value for B1 was adopted, but the aggregate price index from the pre-revision series was used to derive the value at prices of the previous year. Because that aggregate price index was 100.0, the value at prices of the previous year equals the value in current prices:

Item	Current prices	Previous year's prices	Price index
B1	2 500	2 500	100.0

The consequence is that the changed composition within B1 is not reflected in the value at prices of the previous year. The price development of the aggregate remains equal to the old aggregate price index, while the underlying composition has changed. When the underlying detailed items have comparable price developments, this effect is limited. When price developments diverge strongly, as in this example, it can lead to clearly less plausible outcomes.

This issue carries through to the SUTs and IOTs in this project, because they had to align with the aggregate SUTs. As a result, not all values at prices of the previous year could be determined fully on the basis of the underlying detailed information. In assessing the series, greater weight was therefore given to the plausibility of current-price values than to values at prices of the previous year.

For a future revision, it is recommended to build values at prices of the previous year more strongly from the underlying detailed series. This would better preserve differences in price development between detailed items and prevent composition effects within aggregates from disappearing. It would require more computation time and additional checks, but would improve the quality of the series at prices of the previous year.

5.2.5 Concluding remarks

In summary, the SUTs and IOTs from this project should be interpreted as a consistent time series for analyses at an aggregated level. The series are aligned with the revised 2021 framework and make it possible to analyse developments from 2010 onwards in a coherent way. The main limitation concerns the interpretation of individual detailed cells, especially when these are the result of new splits, allocation steps or alignment with aggregate series. The series are therefore suitable for use in publications and analyses, provided that the chosen level of detail matches the research question and that the model-based nature of the series is explicitly taken into account.

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