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Methodological description of the Trend indicator of Output

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Chapter 1 Overview of the Trend Indicator of Output

1.1 Organisation

The Trend Indicator of Output is compiled by the National Accounts Unit of Statistics Finland’s Economic and Environmental Statistics Department. The compiling is performed by one full-time person (summariser) and between two and four other national accounts experts.

1.2 Publication timetable, revisions policy and dissemination

The Trend Indicator of Output is published some 65 days (the first two months of a quarter) or 45 days (last month of a quarter) from the end of the statistical reference month. A calendar showing all future release dates for the current year can be found on the web pages of the Trend Indicator of Output: http://tilastokeskus.fi/til/ktkk/tjulk_en.html.

Trend Indicator of Output data become revised after their first release. It is, therefore, advisable to always retrieve the latest version from the Trend Indicator of Output web pages when using time series.

1.3 Compilation of the Trend Indicator of Output

The Trend Indicator of Output is a derived statistics, the compilation of which is based on the use of indicators formed from basic statistics or other source data. Unlike for annual accounts, exhaustive data on different transactions are generally not available monthly. Lack of coverage means that in most cases the data cannot be compiled directly by summing from the source data. Instead, the Trend Indicator of Output data are interpolated (disaggregated/divided to months) and extrapolated (for latest months) with indicators.

The compilation of data at current prices takes place in five phases. First, the monthly indicator time series are constructed and updated. The indicator time series may be a single source data time series or a weighted combination of several source data time series. The indicator should reflect the monthly development of the respective transaction as well as possible.

In the second phase the indicator time series are benchmarked to the quarterly national accounts (hereafter referred to as QNA) using the proportional Denton method (see Chapter 3.2). As a result of benchmarking, monthly time series are formed until the latest quarter of the QNA. In the third phase the latest months are extrapolated with the help of the indicator using the ratio of the value of the latest QNA and the quarterly sum of the indicator (the so-called quarterly benchmark-to-indicator method).

In the fourth phase data at current prices are deflated according to the average prices of the year before. This produces volume figures at previous year's prices, in which the previous year is always the base year. Before

Economic and Environmental Statistics
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chain-linking the volume series at previous year's prices are benchmarked to the QNA with the pro rata method, that is, each month of a quarter is raised or lowered in equal proportion. Finally, the volume changes in previous year’s prices are used to chain-link a continuous volume series at reference year 2000 prices with the so-called annual overlap method. This series is published as the Trend Indicator of Output.

1.4 Seasonal adjustment and working day adjustment

Seasonal adjustment and working day adjustment are performed in the Trend Indicator of Output with the TRAMO/SEATS method and the Demetra 2.2 software. The data are calculated as original and adjusted for working days for the whole economy and for three main industries. A seasonally adjusted and a trend series are also calculated for the whole economy. Seasonally adjusted, working day adjusted and trend time series are benchmarked to respective time series in QNA after adjustment.

Economic and Environmental Statistics
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Chapter 2 Publication timetable, revisions policy and dissemination of the Trend Indicator of Output

2.1 Release timetable and revisions to data

The Trend Indicator of Output is published some 65 days (the first two months of a quarter) or 45 days (last month of a quarter) from the end of the statistical reference month. A calendar showing all future release dates for the current year can be found on the web pages of the Trend Indicator of Output: http://tilastokeskus.fi/til/ktkk/tjulk_en.html.

The Trend Indicator of Output is not published between calculation rounds even if some data have changed in some other statistics included in national accounts, such as quarterly or annual accounts. Such changes will show up in the next regular publication of the Trend Indicator of Output.

Trend Indicator of Output data become revised after their first release. It is, therefore, advisable to retrieve always the latest version from the Trend Indicator of Output web pages when using time series. The revisions can be divided into those arising from revisions in the source data and revisions caused by benchmarking to the QNA.

Revisions arising from revisions in the monthly source data occur within roughly one year of the initial publication. In each calculation round the time series are recalculated starting from the 1996 data. However, in the revisions of Trend Indicator of Output data from earlier than the most recent one to three months, the benchmarking to the QNA is more significant than the revisions arising from revisions in the source data.

On account of the characteristics of mathematical/statistical methods used in the compilation, it is also always possible that the time series become slightly revised in connection with a new release, even if no changes took place in the source data or annual accounts. The seasonal adjustment methods, in particular, are sensitive to new observations, so each new monthly data will change seasonally adjusted and trend time series for the months preceding it as well. The more the new monthly data differ from the development anticipated by the seasonal adjustment method, the more the preceding months become revised in the seasonally adjusted time series.

2.2 Contents published

The publication format of the Trend Indicator of Output is a free online release comprising a brief release text and time series accessible via the “Tables” link. The entire data content is included in the tables of the online release. The time series start from January 1996.

The tables can illustrate the original index series of the whole national economy and the three main industries, namely primary production,

Economic and Environmental Statistics
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secondary production and services, the working-day adjusted index series as well as change percentages for both when compared with the respective month of the year before. Seasonally-adjusted and trend series are available as index series for the whole economy as well as their change percentages from the previous month.

2.3 Special transmissions

The time series and change percentages included in the online release of the Trend Indicator of Output are also delivered to the ASTIKA service.

The QNA flash estimate for the national economy, which is based on the Trend Indicator of Output, is published at a lag of 45 days from the end of a quarter.

2.4 Metadata

The description of the Trend Indicator of Output is available on the home page of the statistics at http://tilastokeskus.fi/til/ktkk/meta_en.html.

A quality description (in Finnish only) is also available on the home page of the Trend Indicator of Output at:

http://tilastokeskus.fi/til/ktkk/laa.html.

Economic and Environmental Statistics
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14 Feb 2013

Chapter 3 Compilation of the Trend Indicator of Output

3.1 Overall compilation approach

The compilation of the Trend Indicator of Output is based on the use of current price indicator series together with various mathematical/statistical methods. The compilation thus differs from the annual national accounts, which are mostly compiled by direct compilation method[1]. Indicators are quickly released intra-annual statistics or other source data that are considered to represent, or correlate with, national accounts transactions. Indicators are utilised because unlike in the annual accounts, exhaustive data on the values of national accounts transactions are generally not available monthly. Even if exhaustive data were available monthly at some time lag, it would be rare for them to be available in the timetable required by the Trend Indicator of Output, i.e. within 40 or 60 days from the end of a month.

The purpose of the indicator is to track the monthly development of the transaction as well as possible. The indicator time series may be individual time series selected directly from source statistics or weighted combinations of the time series of several source statistics. When constructing indicators one must take into account the accuracy of the used indicators, such as constant upward or downward bias. If constant bias is detected in the indicator, the indicator values are adjusted as needed before benchmarking and extrapolation. The adjustments can be deterministic or based on a statistical model. They may concern the whole time series or only one observation of the indicator time series.

In the calculation of current price data the information of the indicators and the information of annual national accounts is combined using benchmarking and extrapolation methods.

Volume data are compiled by converting current price data first into the previous year's average prices and by chain-linking these previous year's average price data into reference year 2000 prices using the annual overlap method (see 3.3).

3.2 Benchmarking and extrapolation

3.2.1 Benchmarking to the QNA

Current price time series are compiled by first benchmarking the current price indicator time series to the QNA and then extrapolating the latest months with the same indicator. The purpose of benchmarking is to estimate the monthly time series using the indicator time series so that the quarterly

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[1] In the direct compilation method the source data is first summed. Then coverage adjustments and other adjustments are made if required. The use of the direct compilation method requires sufficiently exhaustive source data.

Economic and Environmental Statistics
Samu Hakala, Veli-Pekka Karvinen, Arto Kokkinen,
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levels of monthly time series are equal to the levels of the QNA. Benchmarking can be thought as a solution to the problem: how to combine the quarterly data of the QNA with a monthly indicator data, so that the monthly path of the result time series follows the indicator as closely as possible.

It is essential to understand that the *level* of the benchmarked time series is determined by the QNA, but its monthly *path* by the indicator. Thus the level of the indicator values need not be anywhere near the values of their corresponding transaction; the indicator can be an index series, for example. As a result of benchmarking the original current priced time series are formed ending to the latest quarter of the QNA.

Benchmarking is done with the proportional Denton method[2], which is in essence mechanical. It aims to keep the original month-to-month development as intact as possible, i.e. compatible with the indicator time series. If an observation in an indicator series at point in time t is denoted with i_t and an observation in the benchmarked series at point in time t with x_t, the sum of squares equals

$$\sum_{t=2}^{T}\left[\frac{x_t}{i_t}-\frac{x_{t-1}}{i_{t-1}}\right]^2$$

where T denotes the last month of the time series. The sum of squares is minimised under the condition that the sum of all months of the quarter is the quarterly value obtained from the QNA. Benchmark to indicator ratio BI_t will thus be estimated for every month,

$$BI_t = \frac{x_t}{i_t},$$

which, when the entire time series is considered, deviates as little as possible from the BI ratio of the previous point in time.

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[2] Denton, F.T. (1971), “Adjustment of monthly or quarterly series to annual totals: An approach based on quadratic minimization.” Journal of the American Statistical Association, 82, 99-102.

Economic and Environmental Statistics
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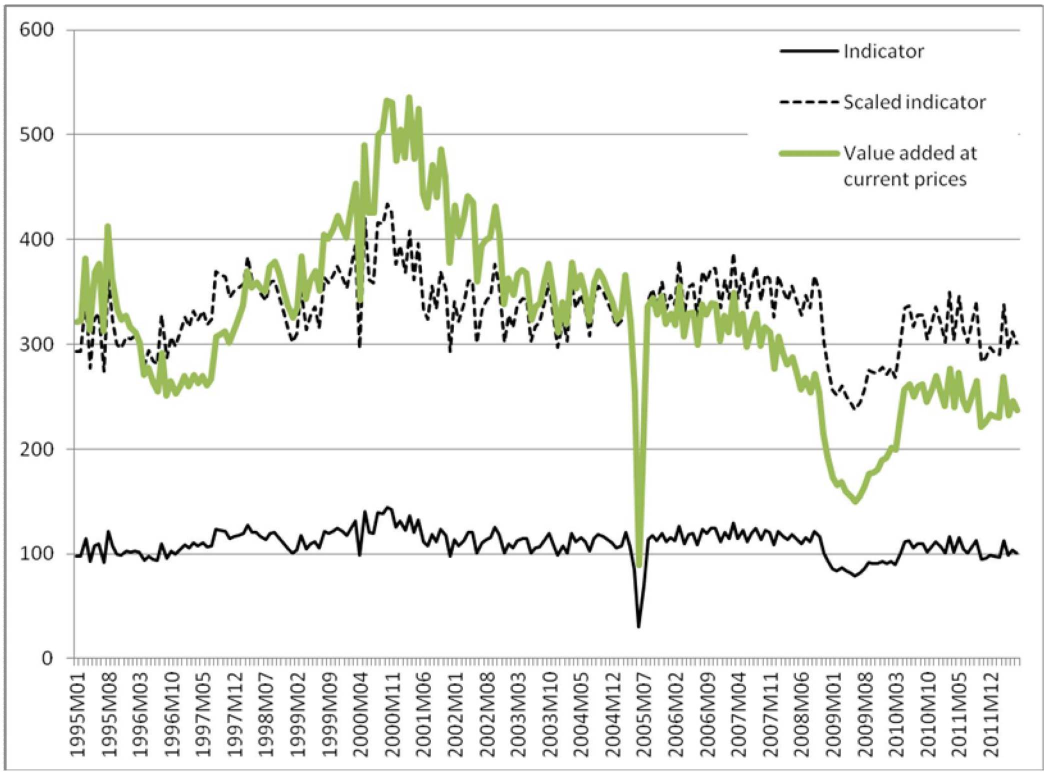
14 Feb 2013

Figure 1: Indicator and a time series benchmarked with the proportional Denton method



The graph above shows the indicator for the pulp and paper industry in the non-financial corporations sector (S.11) and the value added time series formed from it by benchmarking. The indicator in this case is a turnover index (2000=100). For the sake of illustration, a scaled indicator was added by multiplying the indicator values by three. When comparing the scaled indicator and the benchmarked value added time series, it can be seen how the Denton method retains the monthly development of the indicator in the benchmarked time series, even though the quarterly development of the QNA at times differs considerably from the quarterly development of the indicator. Special attention should be given to the dip in the second quarter of 2005, which was due to the shutdown in the paper industry.

There are also various benchmarking methods that are based on time series models and in which the original time series is used as the external regressor. A simple example of this is Chow-Lin[3], and if suitably formulated, the Denton method can also be regarded as a special case of this kind of a model. With the exception of particularly problematic series, the Denton method and methods based on simple time series modelling produce in practice the same benchmarked series, and no reasons for changing the

[3] Chow, G.C. – Lin, A.-L. (1971), “Best Linear Unbiased Interpolation, Distribution and Extrapolation of Time Series by Related Series.” The Review of Economics and Statistics, 53 (4) s. 372–375.

Economic and Environmental Statistics
Samu Hakala, Veli-Pekka Karvinen, Arto Kokkinen,
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method have emerged from the examinations made. The proportional version of the Denton method is also recommended for benchmarking in the IMF's QNA manual[4]. More complex models would make it possible to study interesting connections to seasonal adjustment, for example, but then the benchmarking proper would not necessarily succeed equally reliably. Further reading about time series model-based methods is available in the master's thesis written at Statistics Finland (Hakala, 2005)[5].

3.2.2 Extrapolation

Denton benchmarking creates the original current price time series up till the latest quarter of the QNA, but not beyond. It follows that when compiling the Trend Indicator of Output data one to three months are still missing from the time series after benchmarking. These latest months are calculated by extrapolation. Extrapolation is done with the indicator time series, using the quarterly benchmark-to-indicator ratio.

As a result of benchmarking, the sum of the months in any quarter of the benchmarked current priced time series is exactly equal to that in the QNA. The quarterly benchmark-to-indicator ratio used in extrapolation can then be calculated by dividing the quarterly sum of the latest benchmarked values with the quarterly sum of the respective indicator time series. The quarterly BI ratio thus is the ratio of the latest QNA data to the respective indicator values.

In extrapolation the (latest) values of the indicator time series are multiplied by the quarterly BI ratio:

$$x_t = \frac{x_{Q-1}}{i_{Q-1}} \times i_t,$$

where x_t is the extrapolated value for month t, x_{Q-1} is the sum of the values in the latest benchmarked quarter, i_{Q-1} is the sum of the indicator values in the same quarter and i_t is the value of the indicator in month t.

As in benchmarking, the extrapolation method is selected with a criterion that the resulting current priced time series should follow as closely as possible the development of the indicator. Extrapolated current price estimates can still be adjusted, if needed. Adjustments are made when some additional information, which is not included in the indicator, is available.

The table below illustrates extrapolation. To limit the size of the table the annual BI ratio for the last quarter of 2011 is calculated here: (222+225+233) / (94.4+95.9+99.1) = 2.349689.

[4] http://www.imf.org/external/pubs/ft/qna/2000/Textbook/ch6.pdf
[5] Hakala, Samu (2005), "Aikasarjojen täsmäyttäminen" (In Finnish only; Benchmarking of time series).

Economic and Environmental Statistics
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14 Feb 2013

Table 1: Extrapolation with the quarterly BI ratio

Time period	Indicator	Value (bench-marked), EUR mil.	Value (extrapolated), EUR mil.
2011 Jan	106.4	255	
...	…	…	
2011 Oct	94.4	222	
2011 Nov	95.9	225	
2011 Dec	99.1	233	
2012 Jan	97.3		2,349689*97.3 = 229
2012 Feb	96.6		2,349689*96.6 = 227
2012 Mar	112.5		2,349689*112.5 = 264

3.2.3 Estimation in preliminary data

The availability of monthly and quarterly source statistics that can be used as indicators is good in Finland. From the very first publication most of the data are based on indicators derived from statistical/register sources. That said, particularly in the first publication some of the source data are incomplete and have to be estimated. The most important transactions where the first estimate is based on incomplete data are some of the industries in the non-financial corporations sector, the whole financial and insurance corporations sector and some of the industries in the household sector.

3.3 Volume estimates

3.3.1 Volume estimates in the Trend Indicator of Output

Volume refers to data adjusted for price changes. Volume in national accounts is not simply a measure of quantity, because it also comprises changes in quality. For example, the volume of mobile phone production can grow even if the quantity produced does not change. This happens if the quality (i.e. technical features) of new mobile phones is better than that of old ones. That is why the percentage change of GDP is normally derived from the volume estimates.

The Trend Indicator of Output volume data are published as chain-linked index series (2000=100). Chain-linking means that the volume data of each year are first calculated at previous year’s prices. From these are calculated the annual volume changes, which are then linked together to form a chain-linked monthly or quarterly volume time series.

Economic and Environmental Statistics
Samu Hakala, Veli-Pekka Karvinen, Arto Kokkinen,
Pasi Koikkalainen
tel. +3589 1734 3756

Calculation of volume data starts with deflation, in which current price time series are converted to volume series at the average prices of the previous year by dividing current price values of each month with a deflator.

The deflator is a suitable price or price index for the transaction. In order to convert current price values to previous year volumes, we first calculate the ratio between the monthly price and the previous year's average price. The deflator in this ratio form thus expresses the price level of each month relative to the average price level of the previous year:

$$D_t = \frac{P_t}{P_{Y-1}}$$

where P_t is the price of month t, P_{Y-1} is the average price of the previous year (arithmetic mean) and D_t the ratio value of the deflator.

Several price indices can be used for constructing a deflator for one transaction. In this case P in the equation above is a weighted combination of multiple price indices.

In annual national accounts, output and intermediate consumption are deflated separately (double deflation). In the Trend Indicator of Output however, the value added is deflated directly with output prices. Intermediate consumption is not estimated, because there are no reliable indicators.

The deflators for value added by industry are constructed from product level price data[6]. Product level prices are weighted with the product weights of current price *output* derived from the supply and use tables. Price indices and their weights in the Trend Indicator of Output value added are therefore the same as in the output of annual accounts, except for those few products whose final price data are obtained only at annual frequency.

Because the supply and use tables are completed with a lag of around two years after the end of the statistical reference year, the weight structure of the latest supply and use table is used for several years. For example, the value added data for the years 2009 to 2012 published in October 2012 were deflated using the output weights of the supply and use tables of 2009. The same weight structure was also used in the annual accounts data concerning 2009 to 2011 published in July 2012.

Deflation with the same prices and weights as in annual accounts improves the accuracy of the volume estimates of the Trend Indicator of Output value added. On the other hand, the lack of the intermediate consumption estimates hampers accuracy, which is why the release of annual accounts in July may cause considerable revisions to the value added volumes.

The volume at the average prices of the previous year for month t is

[6] The supply and use tables have 790 products, for each of which a specific price index is defined.

Economic and Environmental Statistics
Samu Hakala, Veli-Pekka Karvinen, Arto Kokkinen,
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$$PYP_t = \frac{CP_t}{D_t}$$

where CP_t is the current priced value and D_t the ratio value of the deflator in month t.

Table 2: Deflation with one price index (NB The average price index for 2011 is 101.7)

Time period	Value at current prices	Price index	Deflator	Volume at previous year's average prices
2012 Jan	114	104.4	102.9 / 101.7 = 1.012	114 / 1.012 = 113
2012 Feb	174	104.8	102.7 / 101.7 = 1.010	174 / 1.010 = 173
2012 Mar	217	105.2	103.4 / 101.7 = 1.017	217 / 1.017 = 214

3.3.2 Chain-linking and benchmarking

Volume estimates at previous year's average prices are benchmarked to the QNA with the pro rata method, that is, each month of a quarter is raised or lowered in equal proportion:

$$x_t = \frac{x_Q}{i_Q} \times i_t$$

where x_t is the benchmarked monthly volume at previous year's average prices, x_Q is the volume at previous year's prices in the QNA, i_Q the quarterly sum of the non-benchmarked monthly volumes at previous year's average prices, and i_t is the non-benchmarked monthly volume at previous year's average prices.

The pro rata method is used in this case instead of the Denton benchmarking method because the previous year's price time series have break points at each turn of the year. As the months of each year are deflated to the previous year's prices, changes at the turn of the year in the time series (e.g. 2007M01/2006M12) are not comparable with the changes within the year (e.g. 2006M12/2006M11). The Denton method aims to retain the changes between all quarters of the original series, which is why the data should be continuous as in the current price time series.

The pro rata method is not recommended for the benchmarking of continuous series, because it creates break points at year turns (step problem) and comparability is lost. However, in this case pro rata is a

Economic and Environmental Statistics
Samu Hakala, Veli-Pekka Karvinen, Arto Kokkinen,
Pasi Koikkalainen
tel. +3589 1734 3756

suitable benchmarking method because the time series already contains break points at each year turn.

After the volumes at the average prices of the previous year have been benchmarked, they are chain-linked to reference year 2000 price volume series with the annual overlap method[7]. The chain-linking starts with a calculation of the annual chain-linked volume index:

$$CL_Y = \frac{PYP_Y}{CP_{Y-1}} \times CL_{Y-1}$$

where CL_Y is the value of the annual chain-linked volume index in year Y, PYP_Y is volume at previous year's prices in year Y (summed from benchmarked monthly volumes), CP_{Y-1} is the previous year's current price value (summed from benchmarked months) and CL_{Y-1} is the previous year's chain-linked volume index. The first year value of the chain-linked volume index can be set to 1 or 100, for instance.

Then, for each month, the ratio of the monthly volume (at previous year's average prices) to the current price average of the previous year must be calculated. The previous year's index value from the chain-linked annual volume index is then multiplied with these monthly ratios, to obtain a monthly chain-linked volume index series:

$$CL_M = \frac{PYP_M}{\frac{CP_{Y-1}}{12}} \times CL_{Y-1}$$

where CL_M is the monthly chain-linked volume index in month M, PYP_M is the monthly volume at previous year's average prices, $CP_{Y-1}/12$ is the previous year's current price monthly average, and CL_{Y-1} is the previous year's value of the chain-linked annual volume index.

The monthly chain-linked volume index time series can be scaled to the level of any reference year by multiplying all the months of the volume index with the same multiplier. The Trend Indicator of Output is published as an index series (2000=100). Thus, the scaling is performed so that the average of all months in the year 2000 becomes 100.

In a chain-linked series, the choice of the reference year is arbitrary and it only indicates that volumes are expressed relative to the current price level of the reference year. To be precise, because price weights change annually in chain-linked volume time series, it cannot be said that the chain-linked volume series are expressed at year 2000 prices.

The drawback of chain-linked time series is loss of additivity, which means that the series cannot be summed with each other. Thus, for instance, a chain-linked volume of total value added is not equal to the sum of its components.

[7] Information on the quarterly accounts volume calculations can be found in the IMF's QNA Manual: http://www.imf.org/external/pubs/ft/qna/2000/Textbook/ch9.pdf. Example of Annual overlap on page 159.

Economic and Environmental Statistics
Samu Hakala, Veli-Pekka Karvinen, Arto Kokkinen, Pasi Koikkalainen
tel. +3589 1734 3756

Because of the properties of the annual overlap chain-linking method, the chain-linked monthly volumes will automatically be equal to the chain-linked QNA (and annual accounts) if monthly volumes at previous year's prices and monthly current price values have first been benchmarked.

3.4 Seasonal adjustment and working day correction[8]

Time series of the Trend Indicator of Output show strong variations between the observation periods of a year, which is typical of time series on economic trends. This is known as seasonal variation. The reasons for this variation could be changes caused in the observed phenomena by seasons of the year that make them favourable for the sales of certain products, and timings of transactions. In addition to the variation between winter and summer months, consumption over the Christmas and Easter seasons, payments of tax refunds and back taxes that in Finland fall due in December, as well as companies' payments of dividends in spring after closing of accounts are examples of causes of seasonal variation in monthly and quarterly time series.

Seasonal variation in a trend series makes the detection of turning points relative to the previous observation difficult. The direction and shape of development in the longer term are also difficult to see from an original series. Indeed, in a time series containing observations at intervals shorter than one year seasonal variation is often seen as a nuisance which has very little to do with the picture of development over a longer time period. The conclusion must not be drawn from this that seasonal adjustment would be standard or deterministic, and that its modelling or adjustment would be a triviality in the way of bigger things[9].

When quarterly national accounts time series are analysed, in addition to the calculation of change from the month a year ago (M/M-12), comparison should also be made to the previous observation (M/M-1). Turning points in the examined variable can be observed by comparing development since the previous observation. To be able to do this, a time series must be broken down to its components and seasonal variation within the year evened out.

It is often suggested that time series on economic trends that contain more frequent than annual observations should be broken down to four components: trend (development over an extended time period), business cycle (medium-term variation caused by economic trends), seasonal variation (variation within one year) and irregular variation. The last one of

[8] Much of this chapter is based on the article "Aikasarjan ARIMA-mallipohjaisesta kausitasoituksesta" (*On the ARIMA model-based seasonal adjustment of a time series*) by Arto Kokkinen ja Faiz Alsuhail (2005). The Finnish Economic Journal, Issue 4/2005, Volume 101, http://www.ktyhdistys.net/Aikakauskirja/sisallys/PDFtiedostot/KAK42005/KAK42005Kokkinen.pdf, as well as on the materials of Statistics Finland's courses on seasonal adjustment (2006) (Kokkinen).

[9] Takala, K. (1994): "Kahden kausipuhdistusmenetelmän vertailua; X11 ja STAMP" (in Finnish only; Comparison of two seasonal adjustment methods; X11 and STAMP), in Suhdannekäänne ja taloudelliset aikasarjat (in Finnish only; Upturn in the economy and the role of economic time series), pp. 67– 103, Statistics Finland. Surveys 210, Helsinki.

Economic and Environmental Statistics
Samu Hakala, Veli-Pekka Karvinen, Arto Kokkinen,
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these is presumed to be random white noise with no information that would be useful to the analysis of the series. Because making an unambiguous and clear distinction between the trend and the business cycle is difficult, these components are usually estimated together, referring to this combination as the trendcycle. When the concept of trend is used in this methodological description it refers to the trendcycle as is typical in analyses of time series on economic trends. When seasonal variation is evened out, a seasonally adjusted series is obtained which contains the trendcycle and irregular variation.

3.4.1 The TRAMO/SEATS method

The ARIMA model-based TRAMO/SEATS method recommended by Eurostat is used in seasonal adjustments of the Trend Indicator of Output and the QNA time series. The ARIMA model-based (ARIMA Model Based (AMB)) seasonal adjustment starts by modelling of the variation in the observation series by means of an ARIMA model. The obtained ARIMA model is utilised in breaking down the variation in the time series into its trend, seasonal and irregular components. The division into the components is done so that the obtained components can be presented with an ARIMA model. The most significant difference from the ad hoc approach (e.g. methods X11/X12, Dainties, Sabl, BV4) is that in TRAMO/SEATS, own, specific filter formulas are built for each time series for the adjustment of the data.

The method also contains an efficient means for making adjustments for working and trading days and for identifying outliers. TRAMO/SEATS also makes it possible to calculate forecasts, standard errors and confidence intervals by component. The program and the method were created by Maravall and Gomez[10].

Whenever a time series is being adjusted, the autocorrelation structure of the original series is interfered with. If the used filter (be it a general ad hoc filter or one based on a wrong model) fails to screen out expressly and only the seasonal adjustment frequencies of a time series, or trend frequencies when trend is being estimated, the autocorrelation structure of the original time series becomes skewed with the temporally repeated characteristics of the original phenomenon.

The ARIMA model-based seasonal adjustment and the TRAMO/SEATS method offer one analytical solution to this problem. In the TRAMO part, the original series is pre-adjusted for e.g. outliers and variations in numbers of working and trading days so that the pre-adjusted series can be ARIMA modelled. This modelling of the autocorrelation structure of the entire pre-adjusted series is utilised when variation in the time series at different frequencies is broken down to its components in the SEATS part.

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[10] See e.g. V. Gomez and A. Maravall (1996): Programs TRAMO and SEATS. Instructions for the User, (with some updates). Working Paper 9628, Servicio de Estudios, Banco de España.

Economic and Environmental Statistics
Samu Hakala, Veli-Pekka Karvinen, Arto Kokkinen,
Pasi Koikkalainen
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The point of departure in the decomposition is that each component should only describe the precise part of the autocorrelation structure of the whole series and the variation that relates to it, i.e. the components are mutually orthogonal. Interpretationally this means that the reasons that cause seasonal variation (such as time of the year) in a time series are uncorrelated with the reasons behind a long term trend, such as investments or R&D activity. In addition, it is presumed that a time series is made up of components that are realisations of linear stochastic processes. Then each component (with the exception of the irregular term) can be described with an ARIMA model.

Both the pre-adjusted series and its components are ARIMA modelled while respecting the dynamic, temporally recurring characteristics of the original series. Finally, the deterministic factors, outliers and variation caused by working or trading days that are observed in the pre-adjustment are assigned to the components as follows: extreme observations of level change (level shift (LS)) to *trend*, variation caused by numbers of working days and trading days (working day/trading day effects (WD/TD)) to *seasonal variation,* and individual outlying observations (additive outliers (AO)) and momentary outlying observations lasting for the duration of several observations (transitory change (TC)) to *random variation.* Thus the variation in the entire original time series becomes distributed to the components of final trendcycle, final seasonal variation and final irregular variations.

Because the said components are initially unobservable in the original time series they can be formed in many ways. In the TRAMO/SEATS method a solution is sought in the decomposition of a pre-adjusted time series where the variance of random variation is maximised. This solution is known as canonical decomposition and it produces an unambiguous decomposition of a time series.

When comparing the variance of the random variation factor (and the component of irregular variation) produced by means of canonical decomposition with other methods, such as the other model-based method, STAMP, and the aforementioned ad hoc methods, it is good to bear in mind that:

1. The modelling of a pre-adjusted time series is made with diverse (pdq)*(PDQ) models[11] of the seasonal ARIMA model family which produces random variation that has quite small variance and is tested to be random.

2. The identification of a seasonal ARIMA model for a pre-adjusted series is based on the Bayesian Information Criterion (BIC)[12] according to which the

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[11] Notations p, d, q refer to the basic ARIMA part of the models and PDQ to the seasonal ARIMA part where p (or P) is the number of ar parameters, d (D) the number of differentiations, q (Q) the number of ma parameters. The model selection of TRAMO/SEATS is based on the following maximum limitations p=3,d=2,q=2; P=1,D=1,Q=1

[12] Min BIC (p, q) = $\log\sigma^2 + \log(p+q)T^{-1}\log T$, where p and q are the numbers of AR and MA parameters in the model and T the number of observations in the time series. When T approaches infinity BIC finds the model produced by the time part on the basis of simulations.

Economic and Environmental Statistics
Samu Hakala, Veli-Pekka Karvinen, Arto Kokkinen, Pasi Koikkalainen
tel. +3589 1734 3756

selection of the model is determined by as small variance as possible in random variation achieved with as small number of estimated parameters as possible.

Thus, before the decomposing SEATS phase the variance of random variation, i.e. the residual of the seasonal ARIMA model fitted to the preadjusted time series, is quite small. The assignment of most of this random variation of an entire time series to the random variation component in the SEATS decomposition phase (and minimising the random variation in other components) cannot be assumed to lead to any greater variance of the random variation component than in the mentioned other methods in which the whole time series is not first modelled with a model of the seasonal ARIMA model family. By contrast, the combination of the deterministic modelling of working and trading day variation often results in a greater variance of the seasonal component in TRAMO/SEATS. In addition, the stochastic modelling strategy of seasonal variation improves the explanatory power on seasonal variation by capturing moving seasonality in time, along with the modelling of working and trading day effects.

In order to reduce the revision of the latest adjusted observations, a forecast for a few observations forward must be produced in all seasonal adjustment methods. It is usually done basing on an ARIMA model, as in X11/X12 ARIMA, even when the seasonal adjustment filter is not at all associated with the model concerned. One logical justification of ARIMA model-based seasonal adjustment is that the filter used in the adjustment of a series is based on the same series-specific ARIMA model with which the forecast is made. In all eventualities, the latest one to three adjusted observations will become revised against new statistical observations in all methods. The revisions are due to a forecast error, that is, new observations differ from the development predicted earlier by the ARIMA model. The larger the differences, the greater is also the revision of the already published seasonally adjusted and trend series.

Economic and Environmental Statistics
Samu Hakala, Veli-Pekka Karvinen, Arto Kokkinen,
Pasi Koikkalainen
tel. +3589 1734 3756

14 Feb 2013

With standard regression and ARIMA model symbols, the phased TRAMO/SEATS method can be presented as follows:

Tramo (**I**) / Seats (**II**):

I) $y_t = x_t{}'\beta + z_t$ [13]

Pre-adjustment regressions
– working/trading day effects (WD/TD)
– outlying observations (LS, AO, TC)

Residual from the pre-adjustment, z_t ARIMA model

II) $z_t = p_t + s_t + u_t$

$$\Rightarrow z_t = \frac{\theta_p(B)}{\phi_p(B)} a_{pt} + \frac{\theta_s(B)}{\phi_s(B)} a_{st} + u_t$$

Residual of the pre-adjusted series after decomposition, random

(pre-adjusted series = (initial) trend + (initial) seasonal component + random variation)

Finally the deterministic factors of part I and the stochastic factors of part II are combined and the original series is divided into its final components:

$$y_t = p_t(+LS) + s_t(+WD/TD) + u_t(+AO,TC)$$

Final Irregular

observation series = trend + seasonal component + irregular component

The above final decomposition shows that when the seasonal component is being removed, calendar effects are also eliminated in seasonal adjustment.

[13] In the TRAMO phase for a pre-adjusted series, z_t, an ARIMA model $z_t = \frac{\theta(B)}{\phi(B)}\varepsilon_t$ is identified.

In the SEATS phase, the lag polynomials of this model, ϕ(B) and θ(B), are divided into trend and seasonal components based on the frequency domain analysis. Part of ε_t is divided into trend and seasonal components, again based on the frequency domain analysis, and the remaining part forms a random residual after decomposition, u_t. In the canonical decomposition the variance of u_t is maximised.

Economic and Environmental Statistics
Samu Hakala, Veli-Pekka Karvinen, Arto Kokkinen,
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3.4.2 Policy for seasonal adjustment

Seasonally adjusted time series and trend series are published for the whole economy as volume series in form of index series (2000=100). Seasonal adjustment of volume series is performed directly, which means that time series are adjusted separately, and e.g. a seasonally adjusted series for the whole economy is not produced by summing together three separately adjusted main industries. Apart from this methodological description that is publicly available, the users also receive information about the implementation of seasonal adjustment on courses organised by Statistics Finland and simply by asking about it. The policies adopted in describing the modelling of time series are openness and information sharing.

ESS Guidelines on Seasonal Adjustment[14] define commendable practices of seasonal adjustment for Eurostat and the EU member states. The governing principle in seasonal adjustment is to make the modellings carefully once a year and keep both the deterministic pre-adjustment factors and the identified ARIMA model fixed between annual reviews of the modelling, yet so that the parameter values are re-estimated on each calculation round. An exception to this are outlying observations mid-way through the year, such as a labour dispute, for example. With regard to the main aggregate series, the model of a certain series might be adjusted if the modelling no longer fits the data due to new observations. The main principle is to keep the adjustment filters formed with the identified model for a series (apart from the estimation of parameter values) unchanged so that the adoption of filters does not cause revisions to the history of a seasonally adjusted series on every round. The aim in the updating of parameter values is to produce forward projections with as full information as possible on the past on every calculation round. The objective in this is to reduce revisions to the latest observations in adjusted series when new observations become available.

3.4.3 Policy for working day adjustment

Working day adjusted (more generally calendar adjusted) time series are published as volume series in form of index series (2000=100). In principle, the working or trading day adjustment (inclusive of adjustments for leap years, Easter and national public holidays) is based on the testing of statistical significance during several modelling rounds.

Working or trading day adjustment factors (inclusive of omission of working day adjustment of a series) are not changed mid-way through the year between modelling rounds. In the best case, basing on experiences from modelling examinations from several years over an extended time period efforts are made to find at least for the main series a stable, series-specific solution with meaningful contents.

For the series that are not working or trading day adjusted original series are presented in place of series adjusted for working days. The original series are naturally also published so the congruence of the said series shows that

[14] http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-09-006/EN/KS-RA-09-006-EN.PDF

Economic and Environmental Statistics
Samu Hakala, Veli-Pekka Karvinen, Arto Kokkinen,
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no adjustment for working days has been done to the data describing the phenomenon concerned. In a case like this, the seasonally adjusted series are of course not calendar adjusted, either.

Economic and Environmental Statistics
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14 Feb 2013

Chapter 4 Quarterly flash estimate of GDP

A quarterly flash estimate of gross domestic product is calculated by means of the Trend Indicator of Output, by summing from monthly data. The flash estimate is released with the Trend Indicator of Output with a lag of 45 days from the end of a quarter. The data are submitted simultaneously to Eurostat.

The calculation of the flash estimate is based as exhaustively as possible on the same data sources as the quarterly national accounts. Due to the fast release timetable, fully equivalent data cannot be used. Intermediate consumption as well as taxes and subsidies on products are not estimated in the compilation of the flash estimate, but quarterly GDP is carried forward with an annual change based on the Trend Indicator of Output.

Apart from the aforementioned exceptions, the same methods are used in the calculation of the flash estimate as in the calculation of the QNA, but the calculation is performed on monthly data. Monthly series are summed up to quarterly series. Quarterly series are seasonally adjusted with the TRAMO/SEATS method.