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Task Force on Seasonal Adjustment of Quarterly National Accounts

FINAL REPORT

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1 Introduction

The CMFB requested at its meeting in June 2006 to reconvene the Task Force on Seasonal Adjustment of Quarterly National Accounts (QNA). Further harmonisation in this field has also been requested by the EFC in the Status Report 2005 on Information Requirements in EMU. The existing recommendations of the first joint Eurostat/ECB (DG Statistics) Task Force, approved by the CMFB in January 2002, have substantially promoted the comparability of adjusted QNA data in both the old and new Member States. However, the introduction of chain-linked volume measures for QNA has raised new questions for seasonal adjustment. Furthermore, as regards calendar adjustments a fully consistent and comparable situation across EU countries has not been achieved yet. With the adoption of the revised ESA 95 Transmission Programme in 2007¹ the calendar adjustment of QNA data has become a legal obligation for all EU countries, and this implies that work on implementing from the outset sufficiently harmonised practices is warranted. Finally, in order to respond to a widespread concern of producers and users of QNA data the Task Force has worked on a proposal for a regular supply of metadata which is standardised for all EU countries and Eurostat.

Between February 2007 and December 2007 the Task Force held four meetings. Participants from 19 EU countries actively contributed to the discussion (for a list of Task Force participants see annex 5). In July 2007 the Task Force provided a short interim report to the CMFB. In January 2008 the Task Force has submitted its final report for approval to the CMFB. Close co-ordination between the work of the Task Force and the ongoing work of the Eurostat/ECB Steering Group on Seasonal Adjustment was ensured and the recommendations of the TF are, where overlaps exist, generally consistent with the ESS Guidelines, as proposed by the Steering Group.

¹ Regulation (EC) No 1392/2007 of the European Parliament and of the Council of 13 November 2007 amending Council Regulation (EC) No 2223/1996 with respect to the transmission of national accounts data.

2 Mandate

The mandate of the Task Force covers the following aspects in the context of compiling seasonally adjusted QNA:

- Review and specify further those existing recommendations that may be affected by the introduction of chain-linked QNA volume measures, i.e. the recommendations on accounting identities and the treatment of discrepancies of seasonally adjusted components and aggregates, as well as the time consistency between adjusted quarterly and annual results.
- Review and specify further the practices for working-day adjustment and the treatment of irregular factors (e.g. special weather or leave influences); propose methods how to obtain separate information on working-day and seasonal factors.
- Examine and propose a common approach for purely working-day adjusted components of table 1 that will be provided mainly on a voluntary basis under the amended ESA95 transmission programme.
- Examine further, for selected components of ESA95 Table 1, underlying causes of the significant divergences in the seasonal and working day correction factors currently used.
- Prepare a proposal for the collection, maintenance and dissemination of information on national and Eurostat practices for the seasonal and working-day adjustment (metadata).

Furthermore, the mandate requested that the Task Force should take due account of the CMFB recommendations for seasonal adjustment of quarterly national accounts of 2002 and the forthcoming amendment of the Transmission Programme of the ESA 95 Table 1, in particular the expected changes for the transmission of working-day adjusted results. The Task Force should also take due account of the recommendations of the work of the Steering Group on Seasonal Adjustment.

3 Differences in seasonal and calendar patterns and adjustment in EU countries

According to its mandate, the TFSA QNA was required to “*examine further, for selected components of ESA Table 1, the underlying causes of the significant differences in the seasonal and working day correction factors currently used*”. For this purpose the Task Force provided detailed information on QNA data sources and adjustment practices. The survey was divided into three country groups in order to broaden the scope of the comparison, and to limit the response burden. The focus was on the determinants of the quarterly profile of national accounts, common factors and existing differences.² By reporting information for 15 EU countries, and covering all components of domestic demand (except changes of inventories) as well as most output components of GDP, the study provides a comprehensive picture of the determinants of the seasonal and calendar patterns. For an overview of the results see the end of this chapter.

3.1 Survey results

3.1.1 Determinants of the seasonal component

Despite all country-specific issues there are strong common determinants of the seasonal components across countries. In particular, the effects of quarterly variations of energy use, tourism activity, weather conditions, salary bonuses and Christmas effects as well as institutional or administrative practices are quoted by all 15 countries. The impact of these factors on total GDP depends on the size of the effect and the share of the component concerned in total GDP. The seasonal variations in most country data are higher than in the (average) European aggregates, though there are exceptions for some QNA series (e.g. government consumption, see below). Furthermore, the seasonal pattern of the smaller countries and the new EU Member States often differs significantly from the EU averages, and has changed significantly over the last decade reflecting the rapid economic changes they have experienced.

One example for a common determinant of seasonal effects is the pattern that the energy production (NACE E) has on value added. High seasonal factors in Q4 and Q1 and counter effects in Q2 and Q3 influence the aggregate despite the fact that NACE E contributes less than 5% to total value added (see Table 1, in brackets share in whole economy value added 2005).

² See for the complete study “Case study on Differences in Seasonal and Calendar Patterns across 15 EU Countries”, TF-SAQNA-17 Rev 2, November 2007.

Table 1: Industrial Production NACE E (energy) - seasonal factors (period averages, 1998-2006;
in brackets: share in total value added)

	CZ (4.2)	EE (3.4)	HU (2.9)	SK (4.9)	SE (3.0)	FI 2.1)
Quarter 1	113.3	121.8	122.3	113.3	114.1	116.3
Quarter 2	93.2	83.0	86.3	90.0	92.2	92.0
Quarter 3	89.3	81.6	79.3	85.6	83.9	84.1
Quarter 4	103.9	113.8	112.2	111.1	109.2	109.9

Source: Eurostat, ECB calculations using monthly data. Data refer to NACE section E except for Slovakia and Sweden (MIG Energy); Sweden and Finland starting 1995 Q1.

While in the case of energy consumption or construction activity the shape of the seasonal pattern is similar across EU countries, there are other seasonal determinants – in particular institutional or structural factors – that may lead to very different seasonal patterns, as illustrated by the example for private consumption expenditure for Italy and the UK (see Tab. 2). Differences in two expenditure sub-groups explain a main part of the different seasonal patterns of aggregate private consumption, i.e. clothing and footwear expenditure (exceptional peaks/lows in UK in Q4/Q1), and a very high seasonal component of restaurant and hotel expenditure in Italy (peak in Q3, low in Q4 and Q1).

Table 2: Differences between seasonal factors of household (domestic) consumption:
Factor for Italy minus factor for the UK

COICOP	<i>Q1</i>	<i>Q2</i>	<i>Q3</i>	<i>Q4</i>	<i>Weight IT</i>	<i>Weight UK</i>
CP010- Food and non-alcoholic beverages	-0.6	-1.4	-1.1	3.2	15.1	9.3
CP020- Alcoholic beverages, tobacco etc	2.2	1.6	2	-6.7	2.5	3.9
CP030- Clothing and footwear	20.6	1.5	8.2	-29.7	8.9	5.9
CP040- Housing, water, electricity, gas etc	-1.3	3.2	1.9	-4	18.4	19.1
CP050- Furnishing, household equipment etc	0	7.5	-3.5	-3.8	8.3	6.0
CP060- Health	1.5	2.5	-3.1	-0.8	3.4	1.6
CP070- Transport	4.4	2.3	-11	4.2	13.8	15.2
CP080- Communication	-2	1.7	-1.3	0.7	2.7	2.2
CP090- Recreation and culture	4.8	2	1.2	-7.8	7.3	12.3
CP100- Education	0	0	0	0	0.9	1.4
CP110- Restaurants and Hotels	-19.2	-7.2	56.8	-30.1	9.4	11.7
CP120- Miscellaneous goods and services	4.5	1.5	0.2	-6	9.4	11.3
Memo: Household consumption total (resident)	2.5	0.4	2.2	-5.1	-	-

Source: National statistical institutes of Italy and the UK. Domestic concept except for overall series.

3.1.2 Determinants of the calendar component

A previous study by the ECB³ illustrated that calendar factors vary considerably across euro area countries and questioned whether this is plausible. In principle, the different number and the timing of public holidays are obviously reasons for differences in the calendar factors. Differences between the deviations of the number of working days from their long-term quarter-specific average of up to one to two working days in a quarter (which corresponds to up to 3% of the potentially available working time, e.g. in the industrial sector) are a major explanation for different magnitude and signs of calendar factors (see table 3 for an example).

Table 3: Number of working days (deviation from quarter-specific average for 1990 to 2008)

	BE	DE	ES	FR
2007 Q1	0.474	0.821	1.694	0.368
2007 Q2	0.211	-0.737	-0.621	-0.053
2007 Q3	0.053	-0.737	-0.765	-0.211
2007 Q4	1.316	-0.974	-0.092	0.421

Source: EU Working Day Calendar (ECB calculations).

Furthermore, the information provided by the Task Force showed that even in countries with similar public holidays the impact on economic variables may be very different, since in several EU countries public holidays falling on a weekend days are compensated by extra leave on the following Monday or in alternative compensation arrangements. This reduces the annual variations of the number of working days and implies that (most) calendar variations become a part of the seasonal component. For example, while in Germany the 1st May (Labour Day) reduces the number of working days in the second quarter only if it falls on Mondays to Fridays, it always reduces the number of available working days in Belgium, Spain and the United Kingdom due to the compensation practice mentioned before. As a consequence, in Germany the effect of the Labour Day is removed predominantly by the adjustment for calendar effects, while in countries compensating for weekend holidays this effect is removed by adjusting for seasonal effects.

Differences of size and direction of calendar effects in GDP are also confirmed by a simple correlation analysis of calendar factors and the number of working days (as a rough indicator of calendar effects) in private consumption. Table 4 indicates that, on average, calendar effects adjusted for by Germany are twice as high as those effects removed by Belgium and Italy. Only for Germany the calendar factors are closely correlated to the variation of the number of working days.⁴ Furthermore, calendar factors used by

³ ECB document on seasonal and working-day adjustment of general economic statistics (GDP and components), Annex 1 to “Implementation of CMFB recommendations on seasonal and working day adjustments in national accounts – progress report”, 32nd Meeting of the Committee on Monetary, Financial and Balance of Payments Statistics, Luxembourg, 29 – 30 June 2006 (CMFB 06/06/A.10.3).

⁴ However, it is not the pure number of working days which is used for adjusting private consumption in Germany for calendar effects. Instead, several regressors are used which take into account, e.g., that the retail trade turnover is different on Sundays and on shop opening days

Germany and Belgium are mutually positively correlated, while the mutual correlation between German and Italian calendar factors is negative. Given the weight of private consumption in GDP this is also a main factor for different GDP calendar effects.⁵

Table 4: Calendar comparisons for private consumption in Belgium, Germany and Italy (BE, DE and IT)

BE	DE	IT
Mean absolute calendar factors		
0.10	0.20	0.10
Correlation of calendar factors and the number of working days		
0.31	0.83	-0.36
BE & DE	BE & IT	DE & IT
Mutual correlation of calendar factors		
0.33	-0.02	-0.52
Mutual correlation of the number of working days		
0.78	0.66	0.64

Source: National central banks of Belgium and Germany, national statistical institute of Italy and ECB calculations.

3.1.3 Statistical factors

Statistical issues appear to play a significant role as well, in particular the nature of the different source data used for QNA compilation used by countries which determines the infra-annual variation of QNA data. For example, one main source for quarterly household consumption may be a monthly or quarterly retail business survey, or a household expenditure survey, or VAT records. These sources may yield different seasonal variations of the derived QNA data. Furthermore, if no suitable data source is available, second-best sources need to be used - e.g. in the absence of suitable output indicators, value added may be estimated from labour input variables such as employment or hours worked, or it may simply be interpolated. This typically impacts on the distribution and magnitude of seasonal variations. Similar issues also exist for the calendar component, and are a major factor for the – in relative terms – very significant differences of calendar factors across countries. In this context it was confirmed that the underlying definition of the calendar component is not yet comparable across countries, i.e. in some countries the calendar adjustment factors also include the seasonal part of the calendar.

The survey also suggests that statistical differences exist as regards the assumptions used for distributing the seasonal variations across values, volumes and deflators. An example for these issues was found for

⁵ For Italy it was noted that the very strong Easter effect and the related tourism activities may reduce the correlation between the number of working days and the calendar factor.

QNA on government consumption in current prices, volumes and deflators (table 5). Two main reasons for seasonal variations are compensation of government employees, extra salaries or bonuses as well as end-of-the-year purchases by government. For government consumption in current prices this leads to a seasonal peak in the fourth quarter in particular in Germany, Spain and Italy, and in the second quarter in the Netherlands. In volume terms, a pronounced seasonal pattern only exists for Germany, Spain, France and the Netherlands. For Belgium and Italy, seasonal variations of the deflator largely correspond to the seasonal variation of the series in current prices, and volume series show little seasonal variations. For the UK, the seasonal patterns of volume and deflator series are small, as it is for the data in current price.

Table 5: Seasonal pattern in government consumption data 2006

	BE	DE	ES	FR	IT	NL	UK
	Current Prices						
2006 Q1	101.1	95.8	82.8	99.6	93.0	95.4	100.7
2006 Q2	101.2	96.7	102.6	102.1	95.8	105.5	100.1
2006 Q3	95.2	98.0	87.6	96.0	91.4	95.4	99.9
2006 Q4	102.7	109.5	125.2	102.1	120.0	103.7	99.4
	Volumes						
2006 Q1	100.1	98.3	96.6	99.5	99.3	95.0	99.8
2006 Q2	100.1	98.4	93.9	101.7	99.6	105.6	99.3
2006 Q3	100.1	99.1	98.8	97.0	99.5	95.1	100.4
2006 Q4	100.1	104.1	110.4	101.6	101.6	104.4	100.5
	Deflators						
2006 Q1	101.1	97.4	85.8	100.1	93.7	100.4	100.9
2006 Q2	101.1	98.2	109.3	100.3	96.2	99.9	100.8
2006 Q3	95.1	98.9	88.7	99.0	91.8	100.4	99.4
2006 Q4	102.7	105.2	113.4	100.5	118.1	99.4	98.9

Source: ECB calculation based on Eurostat data.

Finally, the answers of countries also highlighted that for the adjustments the available software matters (and the options offered by the software), as well as the resources and time which are available for the adjustments. Generally, the QNA calendar components tend to be more significant when derived from detailed and monthly data, and when they are derived from indicator-specific calendar regressions. Furthermore, the original software versions of Census X-12 ARIMA and TRAMO-SEATS have evolved over time (e.g. newer versions have improved and more similar pre-adjustment/calendar adjustment options than older versions), and they offer more choices and alternatives for adjustment than are available to users of interfaces such as DEMETRA.

3.2 Overall assessment

Overall, the case study came to the following conclusions:

- There are **good economic, institutional and structural reasons** that explain divergent seasonal and calendar factors across EU countries.
- However, the **seasonal components** reflect, to some extent, **statistical differences of the QNA source data since the compilation of national accounts at quarterly frequency is less harmonised than the calculation of annual accounts.**
- Moreover, the **calendar components** reflect both the different **QNA source data** as well as the **techniques which are applied for calendar adjustment.** This hampers the current comparability of both the non-adjusted QNA data as well as the purely calendar adjusted QNA.
- Therefore, the **best basis for cross-country analysis** of quarter-on-quarter QNA changes is provided by the **calendar and seasonally adjusted data**, since these adjustments also correct for the “statistically induced” part of different seasonal and calendar patterns.
- Therefore efforts are needed to make the **new purely calendar adjusted GDP data** to Eurostat (under the new ESA95 Transmission Programme) sufficiently comparable for cross country analysis of calendar effects. Only if all countries follow the same definition of the calendar component and apply sufficiently comparable techniques for the adjustment, these data will be useful for analysis.

The determinants discussed in this chapter are summarised in table 6.

Table 6: Overview of determinants for seasonal and calendar patterns

Determinant	Impact (examples)
Economic, socio-economic, institutional and other non-statistical factors	
GDP (or other QNA aggregate) composition	Different industry structures or different consumption structures across countries combined with different seasonal and calendar factors which vary across components, e.g. for construction or tourism
Climatic/weather conditions	<p>Winter trough in construction, investment</p> <p>Winter peak in energy production and consumption</p> <p>Summer peak in tourism output and consumption</p>
Bonus payments, extra salaries etc.	<p>Income and consumption peaks in Q4 (and sometimes Q2/Q3)</p> <p>Government output variation when compiled from inputs</p>
Administrative effects	Tax incentives for end-of year investment or consumption, anticipated end-of year purchases; administrative rules for car registrations, or housing permits; regulations for sales periods or shopping hours
Income level differences	Seasonal profile may be higher when average income is lower (because holiday season and purchase of consumer durables are concentrated in one period)
Varying intermediate consumption	Repairs may be carried out in summer
Country specific public holidays	The number of public holidays varies across countries
Compensating for weekend holidays	In several countries public holidays falling on weekends may be compensated by extra leave on the following Monday
Other habits and conventions	Factory closure over summer leave periods

Statistical factors	
Frequency of QNA sources	<p>When no suitable quarterly source data is available, quarterly data are obtained by temporal disaggregation of annual data which may reduce seasonal variations (e.g. some services, government services)</p> <p>When no suitable monthly indicators exist, calendar adjustment may yield less significant results</p>
Alternative “good quality” sources for QNA	For private consumption, business surveys, household surveys and administrative sources may yield different seasonal patterns or calendar effects (e.g. retail trade survey, HBS and tax registers)
Proxy sources	Second-best proxy sources may imply different seasonal and calendar patterns (e.g. using employment data for estimating value added)
Recording practices	Practices for recording value added at quarterly frequency may not always be in line with rules for annual accounts, e.g. for government expenditure
Information on intermediate consumption	Most countries compile value added data assuming constant infra-annual intermediate consumption shares, some countries use varying shares which impacts on the seasonal pattern of value added series
Definition and estimation of calendar component	The definition and estimation of the calendar component still varies greatly across countries
Other factors	
Software	Some software used may offer only limited choices, in particular for calendar adjustment
Resources (spent)	Some institutions cannot spend resources that would be required for meeting CMFB recommendations, and/or rely on software default options (e.g. for calendar adjustment)

4 Calendar effects and calendar adjustment

According to the mandate, the TFSA QNA was required to:

- Review and specify further the practices for working-day adjustment and the treatment of irregular factors (e.g. special weather or leave influences); propose methods how to obtain separate information on working-day and seasonal factors.
- Examine and propose a common approach for purely working-day adjusted components of Table 1 that will be provided mainly on a voluntary basis under the amended ESA95 transmission programme.

The mandate stressed that the Task Force should take due account of the CMFB recommendations for seasonal adjustment of quarterly national accounts of 2002 and the amendment of the ESA95 transmission programme (Table 1), in particular the changes for the transmission of working-day adjusted results, in liaison with the recommendations and the work of the Steering Group on Seasonal Adjustment.

For this purpose the Task Force examined and discussed calendar adjustment effects on the basis of the experiences and of the methodological and practical studies performed in some Member States. Such analysis provided the key elements to be considered in reviewing the recommendations on the treatment of calendar effects. This chapter reports the main outcomes of the discussion that focussed on additional and open issues left by the 2002 report. Whenever the text refers to the recommendations on calendar adjustment elaborated by the Task Force (see section 7.2), the relevant part is highlighted in bold.

4.1 Definitions

Very often the terminology used in defining the elements that intervene in the treatment of calendar adjustment generates misunderstandings and similar definitions could be interpreted with different meanings in different contents. The Task Force felt that a constructive discussion on calendar adjustments had to be based on an agreed terminology. To this aim, a draft glossary on calendar effect related items has been produced by the Task Force (see annex I). The Task Force recognised also the complexity of setting up an exhaustive and coherent glossary on calendar effect related items in an independent way from a general glossary on seasonal adjustment terms. Therefore, it suggested that the calendar effect draft glossary is considered by the Seasonal Adjustment Steering Group and as an input to be integrated and harmonised with a possible general seasonal adjustment glossary.

4.2 Calendar adjustment

Calendar effects are defined as the impact of working/trading day, fixed and moving holidays, leap year and other calendar related phenomena (e.g. bridging days) on the time series under review. The 2002 recommendations identified calendar effects relevant for QNA as any working or trading day, moving

holiday and leap year effect. However, for the reasons provided in the text below, QNA data shall neither be adjusted for bridging day effects nor for effects related to school holidays or hours actually worked. Calendar adjustment, as a complement to seasonal adjustment, removes from a time series the part of those effects that would not be captured by the seasonal component, i.e. which does not reoccur year after year in the same period. For the sake of meaningfulness and statistical quality of calendar adjusted results calendar adjustment removes those calendar effects for which there is statistical evidence and an economic explanation. Additionally, calendar effects for which a series is adjusted have to be sufficiently stable over time, or, alternatively, it should be possible to estimate their changing impact over time appropriately. The 2002 recommendations stated that other effects, such as temperature, school holidays, etc. may explain the short-term behaviour of a series but such series should not be corrected for these effects, suggesting a decision case by case and special analysis of the impact of these effects for specific needs. The Task Force, following the mandate of the CMFB, further analysed these effects.

For calendar adjustment a regression approach is recommended. Calendar regressors shall represent the calendar phenomena relevant for the time series under review, e.g. by reflecting the calendar situation for the respective economic activity in the respective country.⁶ In order to adjust for the non-seasonal part of calendar effects calendar regressors are constructed as deviation of the number of working or trading days, leap year days etc. from the respective month- or quarter-specific average. When abstracting from the fact that the leap year is omitted every 400 years the period of a calendar is 28 years. Therefore, the month- or quarter-specific averages should be compiled over such a period of 28 years. If this is not feasible, it should be checked to which extent this might be relevant concerning the proper specification of the calendar component.

4.2.1 Bridging days

Bridging days are (up to two) days lying between a public holiday and a weekend.

Bridging days are often taken as extra holidays in connection to the associated public holiday and weekend. This habit could have an influence and modify the "working day" nature of a bridging day. Therefore, the bridging day effects could be included in the working day adjustments. On the one hand, empirical analysis demonstrates that the impact of a single bridging day can be estimated on average for certain time series (in some cases a bridging day could be quantified as a half working day). However, the impact of two bridging days is much more difficult to detect from a statistical point of view. Even more problems appear when interpreting the results of a single bridging day adjustment. Empirical analyses also show that the impact of a single bridging day may differ according to whether it falls within the

⁶ INE Spain presented a paper to the Task Force which demonstrated that user-specified calendar regressors, constructed to take account of national and/or regional public holidays, may show less pronounced peaks in the spectrum of the regressor at those frequencies most relevant for calendar adjustment than standard calendar regressors, as, e.g., provided by TRAMO-SEATS. Rather, the spectra of those user-specified regressors might reflect other local peaks which are smaller, but significant and may appear at frequencies, which are typically related to other effects. (See Navarro, L. (2007): "A note on the use of calendar regressors – Draft paper", TF-SAQNA-40.) The Task Force suggested that more research may be devoted to this topic.

Christmas period or during the rest of the year. In the former case, the impact is softened due to the Christmas effect (industries may be already closed for holidays). Moreover, bridging days may be sensitive to the economic situation and be more or less intensively used in connection with the business cycle (more use of bridging days when the economy is experiencing a weak phase). Furthermore, given that the total leave days granted are fixed, one may expect a counter-bridging day effect in other periods of the year. If the effect of the concentration of leave on single bridging days is eliminated, the countermovement of less leave should actually also be removed from the series for the rest of the year so that no distortion of the business cycle occurs. However, since these counter-effects are not identifiable, it is not possible to estimate all these effects with any statistical certainty.

Eventually, despite that in some cases (industrial output) the impact of a single bridging day is quantifiable on average, in almost all cases the impact tends to depend on specific circumstances (e.g. the accumulation of bridging days in a certain period and/or the prevailing business cycle), so that considerable need for explanation may remain. This leads to the conclusion that the **adjustment for bridging day effects is not recommended**. However it might be useful to model these effects in order to improve the estimate of the seasonal and calendar components if there is clear statistical evidence and if sufficient and sounded information is available. The work flow of such an approach would be: modelling and adjusting these effects, then estimating the calendar and seasonal components and finally adjusting the unadjusted figures only for the normal calendar and seasonal effects; therefore the bridging day effects would be visible in the final seasonally and calendar adjusted time series.

4.2.2 School holidays

School holidays are periods in which classes are not given.

The economic activity in a month/quarter may depend on the schedule of school holidays. Workers with school-age children take leave above all during the school holiday periods. Since the schedule of the school holidays in a country/region may change from one year to another, their effects do not always arise in the same season with the same intensity.

The effects of school holidays on production are linked to the differences between the normal production processes during the week and the vacation period. School holidays are often established at the regional level and can affect different periods in different years (notably between June and August for summer holidays). Their effects are difficult to quantify in particular because they may be related to other seasonal/calendar effects. They may also generate counter-effects (less holidays in other periods of the year).

Therefore, **the adjustment for school holidays is not recommended**. However, these effects could be modelled in order to improve the estimate of the seasonal and calendar components if there is clear statistical evidence and if sufficient and sounded information is available.

4.2.3 Weather effects

Weather effects are effects that are linked to specific weather conditions and that do not occur repeatedly with the exact same intensity in the same period of each year. The non-seasonal part of weather effects is associated to exceptional/atypical weather conditions. Weather effects can affect different economic activities in a different way (for example, construction, tourism services).

A typical example of a weather effect is the impairment of construction activities in the cold season. This effect depends on the intensity of the cold season and above all on the length of the frost period.

The weather effect could be modelled by using suitable indicators (regressors) to catch specific weather situations. Examples are the number of freezing days in a month or the number of snow days in a month, for the cold season, or the number of sunny or raining days, for the warm season. However, the discussion in the Task Force also showed that adjustments for these effects are not straightforward and difficult to communicate to users.

There are various reasons why it is difficult to estimate weather effects, e.g. since the isolation of the non-seasonal part of a weather effect in “real-time” at the most recent end of a time series is usually prone to a substantial amount of uncertainty. Also technological progress may impact on the effect weather conditions have on economic activity. Additionally, it is even more difficult to estimate and eliminate the positive counter-effects, for example those in the second quarter after an impairment of output in construction in an exceptionally cold first quarter. The adjustment for counter-effects would be required, in order to avoid a misspecification of the business cycle if a series had been adjusted for the non-seasonal weather effects.

Therefore, **specific weather-related adjustments are not recommended**. However, these effects could be modelled separately in order to improve the estimate of the seasonal and calendar components if there is clear statistical evidence and if it can be derived from reliable indicators. Care should be taken that this modelling does not lead to an over-adjustment of the series and can be explained to users of the data.

4.2.4 Adjustment for effects related to actual hours worked

It is sometimes argued that the adjustment of calendar effects should not be based on regressors directly derived from the working-day calendar, but rather to extend the adjustment to the effects of the number of days *actually* worked or, preferably, the *actual hours* worked. The assumption is that this practice may avoid the occasionally perceived over- or underadjustment for calendar effects when anecdotic evidence suggests that *potentially* available working time, as quantified by the number of working days in the context of calendar adjustment, was not *actually* used for production (e.g. when companies close for a longer period around Christmas due to low stock of orders in times of weak demand).

However, using the *actual* hours worked for calendar adjustment would produce hardly interpretable results. According to the concept of calendar adjustment, the regressor to be used for adjusting for the impact of hours actually worked would be the non-seasonal part of hours actually worked, i.e. the

deviation of the actual hours worked from the respective month/quarter-specific average. This implies that not only the calendar-related part of hours worked would be considered by the regressor, but also all deviations from the month/quarter-specific average that are due to irregular and trend/business cycle effects. As a result, the time series under review would be adjusted not only for normal calendar influences, but also for the trend, the business cycle and the irregular effects stemming from the hours actually worked. The outcome, while providing “smooth” results, would not be in line with a common understanding of a calendar adjusted series and would hardly provide any relevant information for conjunctural analysis.

An alternative approach would be to use instead only the irregular component of the actual hours worked regressor for the calendar adjustment. This would avoid an adjustment of the time series under review for business-cycle and trend effects. Unfortunately, this approach has other important drawbacks due to the estimation uncertainty of the irregular component for observations at the current end of a series. This requires to accurately distinguish between the trend-cycle component and the irregular component, which is particularly difficult when a new turning point appears. Before such a turning point can be identified on the basis of further time series values, its effect would be in many cases wrongly assigned to the irregular component. If a time series was adjusted with such a misspecified irregular component of the actual hours worked, it would also be adjusted for possible turning points at the current end.

In the view of these severe problems, the Task Force concluded **not to recommend an adjustment for the days actually worked or the actual hours worked**, while this information may of course be important additional information which is useful for the analysis of the adjusted results.

4.2.5 Arrangements to move public holidays falling on a weekend to working days

In some Member States, like Belgium, Spain, Ireland and the United Kingdom, the pattern of national holidays gives rise to little calendar effects in monthly or quarterly data. This is due to the fact that, because of national legislation, the number of holidays is not affected by the calendar situation, or holidays are moved to the closest working day in case public holidays fall on a Sunday (in that case, they are moved, for example, to Monday, which lies in almost all relevant cases in the same month of quarter) or special arrangements for recuperating public holidays have been put in place. In these cases, series might not be adjusted for effects related to public holidays, or adjusted only when strong significant statistical effects are detected.

4.2.6 Calendar effects over time

Calendar effects are normally estimated by means of a regression model with fixed coefficients, in which it is assumed that the impact of a specific calendar regressor is constant over the time period for which the calendar adjustment is done. This assumption might be unrealistic for certain time series observed over a long period of time. The use of certain regressors defined for selected sub-periods and/or the use of time-varying coefficients for calendar effects could help to improve the quality of the calendar adjustment.

Empirical analysis confirmed this assumption for certain time series and showed that a time-varying approach in estimating the coefficient may produce improved calendar adjusted time series. Nevertheless, the unavailability of sufficiently long time series for modelling this time-varying effect and the production constraints associated to the estimation of quarterly national accounts clearly stress the limit of such an approach.

Therefore, whilst modelling calendar adjustments according to time-varying coefficients is an attractive and statistically founded option to improve the estimate of calendar components of certain time series, notably trading days, implementation aspects, the availability of short-time series and the complexity of the estimation process in a production environment strongly limit its practical application.

The Task Force also agreed that, in order to ensure that the estimated calendar component is sufficiently stable over time, the selection of relevant calendar effects used for calendar adjustment should be kept constant for an appropriate time period (e.g. at least one year), even if the value of statistical indicators might be at the border of the significance range. Changes in the selection of calendar effects should be based on both empirical evidence and economic explanation.

4.3 Regional and national calendars

Holidays not established in all parts of Europe, or of a country, but only in some countries, or regions, are not to be treated as full holidays since they affect the European or national aggregates to a different degree than full holidays. The effect of national and regional holidays on European and national calendar regressors has to be evaluated in relation to the relative weight of the country or region on the European and national totals of the investigated time series. These shares may vary depending on the indicator and time period and directly affect the European and national calendar regressors.

The use of national/European calendar regressors that take into consideration regional/national holidays improves the quality of the calendar adjustments since these calendar regressors reflect country-specific calendar situations, e.g. the differences of working days/holidays in association with the production process. The derivation of the regional/national information requires both a deep knowledge of regional/national habits, i.e. basic information, and a meaningful weighting scheme. In practical terms, the inclusion of regional/national working days/holiday information requires assigning to regional/national calendar regressors a suitable weight for the national/European aggregation. In some cases, the weighting scheme could be based on other than national accounts indicators, like, for example, the industrial production.

Regional holidays should be taken into account in compiling national calendar regressors by using regional weights. **The use of regional calendar information is recommended in order to improve the estimate of the calendar effects** provided a clear statistical evidence of different regional impacts on indicators and the measurability of these impacts.

In the same terms, national holidays should be taken into account in compiling directly adjusted European aggregates combining them in a European calendar regressor by using national weights. **The use of national calendar information is recommended in order to improve the estimate of the calendar effects** provided a clear statistical evidence of different regional impacts on indicators and the measurability of these impacts.

4.4 Indicator-, sector- and industry-specific calendar regressors

The use of specific national (based on regional information) and European calendar regressors adapted for each indicator, sector and industry is in principle advisable; nevertheless, for harmonisation and balancing purposes inside the system of National Accounts, the use of such specific calendar regressors could imply a more diverse impact on individual series than the single national calendar approach.

4.5 Supply of calendar adjusted data under the ESA95 Transmission Programme

The Regulation (EC) No 1392/2007 of the European Parliament and of the Council of 13 November 2007 amending Council Regulation (EC) No 2223/96 with respect to the transmission of national accounts data, states that "*Main aggregates) Quarterly data are to be provided in non-adjusted, as well as seasonally and working-day adjusted format. Gross domestic product (B.1*g) and total gross value added (B.1g) must also be provided in working-day adjusted format. The provision of other aggregates in working day adjusted format is voluntary*", where working-day adjusted format means calendar adjusted.

Therefore, starting from January 2008, Member States have to regularly transmit pure calendar adjusted figures for gross domestic product and total gross value added to Eurostat, complemented, in case, by other quarterly main aggregates on a voluntary basis.

The transmission of the compulsory item has to cover current prices, chain-linked volume measures and previous year prices. The transmission has to be made using the same templates and data structure definition (key family) used for the transmission of the other items of Table 1 of the ESA95 transmission programme.

Eurostat is aware that in some countries the derivation of pure calendar adjusted figures is not straightforward due to the specific way of implementing seasonal adjustment in the compilation process. If the provision of the pure calendar adjusted figures for the two compulsory items results extremely difficult in practice, for a transitional period, Eurostat will request the equivalent information to derive the pure calendar adjusted figures.

4.6 Metadata on calendar adjustment

Publicly accessible metadata on seasonal and calendar adjustment practices are very desirable to understand the adjustments for seasonal and calendar effects and the various practices applied by the national institutes and Eurostat. In particular, since the calendar adjustment requires a deep knowledge of national and regional aspects and can vary considerably among Member States, metadata on this aspect are particularly important. In this sense, the proposed metadata template (see chapter 6) aims to collect, by group of variables, the relevant aspects of the calendar adjustment and of other pre-adjustments, if applied.

5 Chain-linking and seasonal adjustment

The mandate of the Task Force on Seasonal Adjustment of QNA requested to “*review and specify further those existing recommendations that may be affected by the introduction of chain-linked QNA volume measures; i.e. recommendations on accounting identities and the treatment of discrepancies of seasonally adjusted components and aggregates, as well as the time consistency between adjusted quarterly and annual results.*”

The annual chain-linking of QNA Laspeyres volume indices in average prices of the previous year has been introduced by almost all statistical institutes in the EU, following the requirements of the Commission Decision 98/715⁷. The Commission Decision stated that, as a guiding principle, the quarterly accounts shall be consistent with the annual accounts. The term “chain-linked measures” is used in the following for series obtained by annual chain-linking of Laspeyres volume indices in average prices of the previous year.

The introduction of chain-linking on a quarterly basis has raised four main new issues which may become relevant for the seasonal adjustment of the respective time series:

- Chain-linked volume measures at a quarterly frequency have different time series properties than volume measures in prices of a fixed base year, since the price basis changes every year, and volume changes of successive years are chain-linked. Depending on the chain-linking method applied, breaks may occur in the chain-linked unadjusted time series, which may have an impact on their seasonal pattern.
- Over the four quarters of a calendar year unadjusted chain-linked quarterly volume measures may, depending on the chain-linking method used, not be consistent with the independently derived chain-linked annual volume measure. A lack in time consistency may require chain-linked quarterly volume measures to be adjusted for these differences. In the following, this adjustment is called “benchmarking”.
- Chain-linked totals and their components are normally not additive.⁸ The only exception is that annually chain-linked Laspeyres volume indices in average prices of the previous year are additive in the year after the reference year. On the other hand, accounting identities are satisfied for unadjusted volumes in average prices of the previous year. This may imply changes to the way seasonally adjusted volume aggregates are calculated, and differences between adjusted aggregates and the respective adjusted components are treated.
- The compilation of chain-linked QNA volume measures implies an increase in the number of calculation steps and, depending on the chain-linking method, the amount of data needed for chain-

⁷ OJ L 340, 16.12.1998, P. 33

⁸ “Additivity ... implies that at each level of aggregation the volume index for an aggregate takes the form of a weighted arithmetic average of the volume indices for its components with base-period values as weights.”
Source: 1993 SNA, Paragraph 6.55.

linking, benchmarking, aggregation and disaggregation for producers and also for users. The calculation steps and required data depend on the method used for chain-linking quarterly volume measures.

The following sections describe the chain-linking techniques used in the EU (5.1) and their potential impact on seasonal adjustment (5.2). Furthermore, the aspects identified by the Task Force concerning the consistency of non-adjusted and adjusted data are outlined (5.3 and 5.4). Finally, the issue of direct vs. indirect seasonal adjustment is addressed (5.5). Whenever the text refers to best practices which were eventually considered for the recommendations (see section 7.3), the relevant part is highlighted in bold. The results presented in this chapter particularly benefited from the work of an informal sub-group on chain-linking which contributed theoretical and empirical results.⁹

5.1 Chain-linking techniques used for compiling QNA

In the EU, QNA chain-linked volume series have unfortunately been introduced in a non-harmonised manner. Three techniques have been used, i.e. the annual-overlap, the one-quarter-overlap and the over-the-year technique. While the annual-overlap technique is applied by the vast majority of the statistical institutes, the one-quarter-overlap technique is used by the UK's Office for National Statistics (ONS) and the Austrian Institute of Economic Research (WIFO). The statistical institute of the Netherlands applies two different chain linking techniques, the over-the-year technique for unadjusted figures and the annual-overlap technique for adjusted figures. Sweden and Bulgaria currently use the over-the-year technique, but have plans to switch to another linking technique. In Belgium, Spain, France, Italy and Portugal, QNA are basically derived from Annual National Accounts (ANA) by referring to quarterly or monthly indicators (indirect approach). Disaggregating quarterly chain-linked volume series from annually chain-linked volume series leads for Belgium, Spain, France, Italy and Portugal to results with identical statistical characteristics as those obtained by the annual overlap approach.

QNA chain-linked volume series are obtained by referring to relative prices which represent the structure of the annual averages of prices of the respective previous year. Creating a time series by applying one of the three chain-linking techniques normally induces structural breaks in the resulting chain-linked series, the impact of which is determined by the chosen linking approach and by the change of the price structure over time.

By referring to annual average nominal values of the respective previous year in prices of that year, the annual-overlap approach produces results whose annual aggregates are identical to the respective, but independently derived chain-linked ANA series. Moreover, the quarter-on-quarter rates of change within the same calendar year (between Q1 and Q4) are not affected by breaks. However, the volume series is

⁹ Robert Kirchner (DE), Sven Öhlén (SE), Marcus Scheiblecker (AT), Luis Biedma and Ingo Kuhnert (Eurostat) and Martin Eiglsperger (ECB).

affected by breaks occurring from the fourth quarter of a year to the first quarter of the following year, which also appear in the respective quarter-on-quarter rate of change.

By contrast, the one-quarter-overlap approach generally leads to undistorted quarter-on-quarter rates of change for all quarters of the year, since the chain-links refer to the quantities of the fourth quarter of the respective previous year valued at average prices of that year. However, unlike the annual-overlap technique, the one-quarter-overlap approach leads to quarterly chain-linked series which are not consistent to the respective independently derived chain-linked ANA series.

The over-the-year approach of chain-linking leads to undistorted year-on-year growth rates for all quarters, since the chain-links refer to the volumes of the same quarter in the respective previous year, valued at average prices of that year. However, as an inevitable consequence this approach leads to results that are affected by structural breaks in every single quarter, so that each quarter-on-quarter rate of change is affected by a break.

Eurostat conducted a simulation study in which moderate as well as extreme shifts in the price structure and related changes in the quantities - substitution effects - were modelled. As shown in chart 1a, the annual-overlap technique (AO), the one-quarter-overlap technique (1QO) and the over-the-year technique (OtY) lead to very similar results if the substitution effect is weak. Chart 1b reveals that the differences between the series obtained by the three linking techniques become large in cases of extreme substitution. As a reference, the charts also show the results of calculating volumes in prices of a fixed price-base year (“fixed A base”) and, in chart 1b, the series obtained by chain-linking indices valued at prices of the respective previous quarter (moving Q base).

Chart 1a: Chain-linked volume measures - trend and a weak substitution effect in the source data

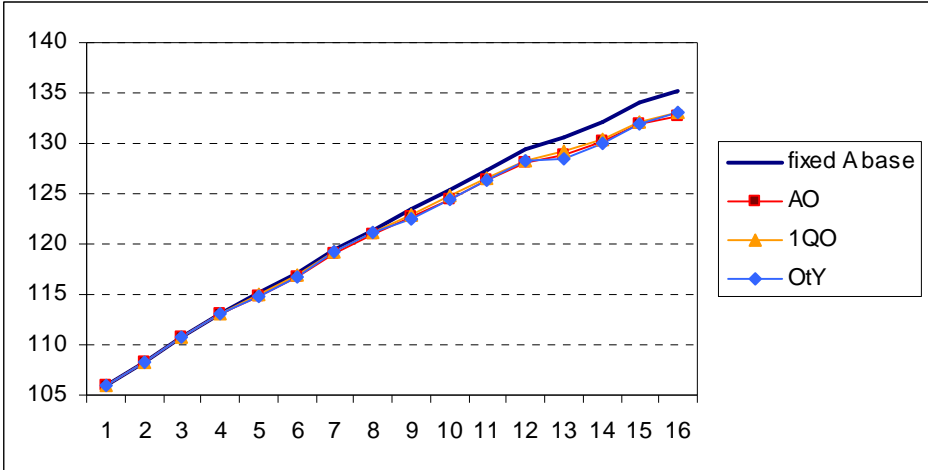
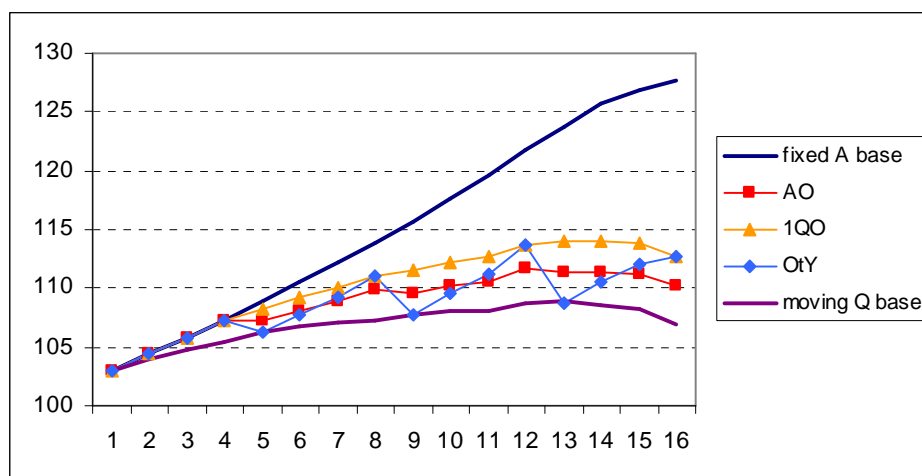


Chart 1b: Chain-linked volume measures - trend and a strong substitution effect in the source data



Source: Kuhnert, I.: “Chain-linking procedures (and additivity)”, presentation held at the first Task Force meeting on 15 February 2007, p. 14 and 16.

5.2 Potential impact of chain-linking on seasonal adjustment

The impact of the application of chain-linking techniques on seasonal adjustment is mainly related to the characteristics of the volume series concerned, in particular the impact of the structural breaks on the quarter-on-quarter development. While the one-quarter-overlap approach avoids any distortions in the quarter-on-quarter rates of change which might be related to the linking technique, empirical evidence available for the annual-overlap technique suggests that the impact of the break from the fourth quarter of a year to the first quarter of the following year is small or negligible for National Accounts main aggregates. Whereas both the annual- and the one-quarter-overlap technique produce undistorted quarter-on-quarter changes in the course of a calendar year, the over-the-year technique induces breaks also between the quarters of the same calendar year. Hence, the over-the-year technique impacts most on the infra-annual profile of a series. Therefore, from the perspective of seasonal adjustment, the use of **the over-the-year technique is not recommended**. Moreover, given that almost all EU countries now apply the annual-overlap technique, full convergence towards this method may be considered for the sake of standardisation in the EU.

Furthermore, if changes in relative prices across detailed QNA components go into the same direction and have a similar impact in some consecutive years, there is a risk that chain-linking techniques may create an “artificial” seasonality to the volume series. Therefore, it is **generally recommended that seasonal adjustment is carried out after chain-linking**. Whenever the arrangements of producing QNA data require seasonal adjustment at an earlier stage, e.g. to make use of very detailed information from quarterly supply-and-use tables also for deriving QNA data in seasonally adjusted form, the result of chain-linking have to be checked in order to avoid that significant seasonality is induced into the seasonally adjusted chain-linked series by applying a linking technique. In cases in which QNA series are

derived from annual National Accounts series, seasonally adjusted QNA are usually obtained by referring to seasonally adjusted indicators.

WIFO conducted a study which compared the three chain-linking techniques for compiling the GDP of Austria. While the results were broadly similar in many respects, in particular those obtained by the one-quarter overlap and the annual-overlap technique, the comparison showed that the applied linking-technique can be relevant for detecting outliers and identifying ARIMA-models. This may impact on the seasonal adjustment, in particular if a model-based approach like TRAMO-SEATS is used. In the WIFO study the detection of outliers was different when the over-the-year technique was used, which resulted in seasonal factors (implicitly derived by dividing the seasonally adjusted series by the non-adjusted series) which differed by 0.2-0.3 percentage points in several consecutive quarters from those obtained by the other two techniques.

5.3 Consistency of non-adjusted quarterly and annually chain-linked volume series

The consistency of ANA and (the sum or average of four quarters of) QNA data is considered important due to the fact that ANA usually rely on more comprehensive source data, whereas QNA are the main source for conjunctural analysis. For this reason, **non-adjusted series** which are **consistent over time** are usually published for data in current prices and for chain-linked volume series obtained by using the annual-overlap technique. Hence, it is a recommendable convention to **force** this consistency for the results obtained by those chain-linking techniques which originally do not fulfil this criterion, i.e. the **one-quarter-overlap and the over-the-year approach**. In order to have the least effect on the short-term profile of a series, benchmarking techniques should be chosen which allow replicating the short-term movements of the non-benchmarked series as close as possible.

In a survey conducted by the Task Force, both Austria and the UK reported that they force their quarterly chain-linked series obtained by the one-quarter-overlap technique to be consistent with the respective independently derived chain-linked ANA series. WIFO Austria applies the interpolation technique developed by Boot, Feibes and Lisman; the ONS uses a cubic spline function.

5.4 Consistency of adjusted quarterly and annually chain-linked volume series

The **consistency of adjusted chain-linked QNA series and respective non-seasonally adjusted chain-linked ANA series** is usually not preserved after seasonal adjustment, even if the raw data are consistent for each calendar year. However, since users consider consistency over time to be important also for adjusted chain-linked data, seasonally adjusted data should be **forced** to be equal to non-seasonally adjusted annual data and correspondingly between seasonally and calendar adjusted quarterly and the calendar adjusted annual data.¹⁰ The benchmarking techniques to be applied for creating time-consistent

¹⁰ Unless there is evidence of significant rapid changes of the seasonal pattern.

adjusted chain-linked series should have the least possible impact on the short-term development of the series. Since benchmarking might impact on the profile of a series and it can not be ruled out that benchmarking induces an “artificial” seasonal pattern, the adjusted series should be checked after benchmarking in order to identify such problems and then apply approaches which avoid this effect.

According to the information collected from Task Force members, the consistency of adjusted QNA series and non-seasonally adjusted ANA series is currently not forced by Bulgaria, Austria and Finland. Germany and Hungary reported in the survey that they apply the so-called the pro-rata approach, i.e. the proportional distribution of discrepancies between the adjusted chain-linked QNA and the non-seasonally adjusted chain-linked ANA in each calendar year. Since this method might result in steps from the fourth quarter of a year to the first quarter of the following year, it is important to closely monitor the impact of its application on the series. The other countries apply methods which avoid the “step problem” by minimising the impact on the quarter-on-quarter movements.

5.5 Additivity of aggregates and components in prices of the previous year

Whereas an aggregate volume measure and its components are additive when the data are expressed in average prices of the previous year, chain-linked series are not additive. Against this background, **it is not recommendable to require forcing the additivity of components and their respective aggregate after chain-linking.**

Unchaining seasonally adjusted chain-linked series produces for each year a separate set of adjusted data in prices of the previous year.¹¹ A set of data in prices of the previous year derived from adjusted chain-linked series is usually not additive due to independent adjustment of an aggregate and its components. Analogously to the reasoning in the previous paragraph, it is not sensible to force additivity in a set of directly adjusted chain-linked series. However, in view of the additivity of non-adjusted data in prices of the previous year, this consistency concept can also be considered for adjusted data in prices of the previous year. One way of achieving this is the indirect method, i.e. by deriving a series in seasonally adjusted form by aggregating its seasonally adjusted components. Whereas the aggregation of the adjusted series has to be conducted for the data expressed in prices of the previous year, the seasonal adjustment itself has to be done for the chain-linked series, since data in prices of the previous year do not form a proper time series. An indirectly adjusted chain-linked aggregate is then obtained by chain-linking the result of the aggregation of the adjusted data in prices of the previous year.

However, adjusting chain-linked volume aggregates directly for seasonal effects can produce better results than obtaining the adjusted aggregate indirectly, namely if the seasonal profile can be better

¹¹ It has to be noted, that unchaining leads in principle to data which are unrelated across years. A comparison of these unrelated data across years may show a seasonal pattern between the fourth quarter of one year and the first quarter of the following year, even if the data in prices of the previous year are derived from seasonally adjusted chain-linked series. In order to indicate that the data in prices of the previous year are derived from seasonally adjusted chain-linked series do not form an adjusted time series in inter-annual terms, the term “seasonally adjusted *data*” instead of “seasonally adjusted *series*” is used in this report.

estimated at a more aggregated level. In this case additivity can only be obtained by additional statistical measures, i.e. by allocating the difference between the directly adjusted aggregate and the aggregate of the directly adjusted components, both in terms of prices of the previous year, to a series of statistical discrepancies or to a series which has residual character (in many countries changes in inventories are an example of such a residual series). Alternatively, it could be considered to distribute the discrepancies over the adjusted components in terms of prices of the previous year. However, the latter approach to treating the discrepancies would require another chain-linking of all the components affected by this distribution, the result of which might be a loss of consistency over time (in the case of the one-quarter-overlap approach).

Overall, **it is recommendable to produce sets of adjusted volume measures which are additive when expressed in prices of the previous year**, since QNA users are typically used to consistent accounting frameworks. The Task Force also confirmed the view that a general clear-cut recommendation in favour or against the direct and indirect approach is generally not possible, since the higher statistical quality of the results obtained by either approach depends on the time series properties. For both the indirect adjustment and the direct adjustment followed by the allocation or distribution of discrepancies adjusted data in terms of prices of the previous year are required. However, from a practical perspective, it has to be noted that deriving seasonally adjusted data in average prices of the previous year from a seasonally adjusted chain-linked series is straightforward only in the case of the annual-overlap approach. Other linking techniques require additional information, e.g. seasonally adjusted data expressed in average prices of the respective year.

Since chain-linked GDP volumes are obtained from the production and the expenditure side, it is usually required that the GDP series obtainable from the two sides are identical, in current prices as well as in prices of the previous year. For seasonally adjusted volume data this consistency could be required in terms of prices of the previous year. However, it has to be borne in mind that this reconciliation might significantly impact on aggregates and components on the production as well as on the expenditure side. This means that forcing the set of adjusted data in prices of the previous year to be consistent across components and aggregates as well as on the production and the expenditure side may result in series which show movements induced by the reconciliation process, which might take the form of artificial seasonality. Therefore, if such a reconciliation is done the resulting series should be tested for such seasonality. If present the reconciliation process should be adapted in way which avoids this problem.

6 Metadata

6.1 Reasoning

Documentation (“metadata”) on QNA source data and quarterly compilation of raw data has been published by many national institutes. However, publicly accessible metadata on seasonal and calendar adjustment practices are in most cases not easily available for the average user. In the view of the complexity of adjusting a set of indicators for seasonal and calendar effects and the various practices applied by the national institutes and by Eurostat, these metadata are very desirable. QNA are calculated independently by the respective national institutes and Eurostat’s calculation of European aggregates is conducted by aggregating national data. From the perspective of full transparency it would be ideal if expert users were in a position to exactly recalculate the adjusted figures. For a large data set such as the numerous indicators covered by Table 1 of the ESA Transmission Programme, this would, however, imply a very substantial amount of information that needs to be produced and maintained for 27 EU countries. Therefore, and in line with the approach taken by the Eurostat/ECB Steering Group on Seasonal Adjustment, the Task Force developed and tested a metadata template which strikes a balance between completeness and a straightforwardly producible, accessible and usable form of presentation. The template may provide a rather complete overview of the information that is typically requested by QNA users. For experts on seasonal adjustment, the template provides a useful starting point, and provides contacts from which more detailed technical information can be obtained, if needed. Furthermore, the template is a useful tool to monitor the implementation of the Task Force recommendations and to broadly assess the comparability of the data.

6.2 Elaboration of a new template and its adaptation to the needs of QNA

The 2002 Task Force on Seasonal Adjustment of QNA created a metadata template for the seasonal adjustment of QNA. While the Task Force and the CMFB agreed that the metadata information is useful and appropriate, it has not been implemented in the follow-up of the Task Force. Therefore, the mandate of the new Task Force requested to “*prepare a proposal for the collection, maintenance and dissemination of information on national and Eurostat practices for seasonal and working-day adjustment (metadata).*”

The Task Force based its work on the revised metadata template on a draft provided by the Steering Group on Seasonal Adjustment in autumn 2007 and adapted it to the requirements of QNA.

For QNA purposes, the Task Force proposes to implement two metadata sheets, with the first and more comprehensive covering ESA Table 1 production, expenditure and income data, and a second covering employment, hours worked and population data. The main sections in the template refer to:

- General information (published series; method used; further links to more information)
- Calendar adjustment (trading-day/working adjustments; calendar used; periodicity of series)

- Other pre-adjustments (outliers etc.)
- Seasonal adjustment (model/filter selection; decomposition)
- Aggregation of adjusted data (direct/indirect adjustment; accounting and time consistencies)
- Revision Policy (model and parameter revision frequency; revision time range)
- Reliability indicators (quality indicators used in s.a. process)
- Links to further structural metadata

The complete template is included in annex 4.

6.3 Implementation

Two members of the Task Force have successfully completed the proposed template.¹² The Task Force also agreed on the necessary steps for a proper implementation, i.e.:

- the template should be available for all EU countries. Eurostat will propose a common file format for the template;
- the national templates should be accessible via the national websites. Furthermore, it is important that Eurostat's website will contain a central page which – possible together with other information on seasonal adjustment practices in QNA – contains the templates for euro area and EU aggregates, and which provides links to all national websites and templates;
- the template should be comprehensive, i.e. covering the key group of quarterly national accounts variables;
- the templates should be updated on a regular basis, e.g. whenever changes to adjustment practices are made;
- furthermore, once a year Eurostat will initiate a co-ordinated update of all templates and, if required, adaptations of the template, reflecting structural changes in the compilation procedures or presentation arrangements, e.g. the introduction of new classifications.

¹² Klára Anwar (HU) and Marcel van Velzen (NL) completed the draft templates and provided comments.

7 Recommendations

This chapter provides the merged and complete set of recommendations on seasonal adjustment of Quarterly National Accounts, as elaborated by the Task Forces in 2002 and 2007. In brackets it is indicated which recommendations are (basically) unchanged from the 2002 recommendations, amended or new.

7.1 General recommendations

- (a) Seasonal adjustment of QNA should cover at least Table 1 of the ESA transmission programme. All series should be tested for the significance of seasonality and calendar effects and adjusted accordingly if these are present.

[basically unchanged recommendation]

- (b) Adjusted data complements raw data, but cannot replace the raw data.

[unchanged recommendation]

- (c) Adjusted results should be produced for data in current prices, volumes and deflators by adjusting any two of these and deriving the third from the seasonally adjusted and benchmarked other two series. When the deflator is the derived one, care should be taken to prevent its path being affected by arbitrary difference in the separate adjustment of current price and volume data.

[basically unchanged recommendation]

- (d) Documentation on the practices adopted at national, euro area and EU level (*metadata*) should be published according to the template on seasonal adjustment of Quarterly National Accounts and the respective arrangements on implementing, publishing and updating the metadata information. The template should be updated at annual frequency or whenever major changes occur.

[basically unchanged recommendation, amended concerning the recommendations on publication, implementation and updating practices]

- (e) There should not be a complete dependence on the automatic default options of the programmes. Seasonal adjustment and Quarterly National Accounts expertise should be used to verify and supplement decisions about the options used (e.g. for outlier treatment, model selection).

[unchanged recommendation]

- (f) For the sake of quality, Census X-12 RegARIMA and TRAMO-SEATS are recommended for seasonal adjustment.

[unchanged recommendation]

7.2 Recommendations on calendar and other pre-adjustment

- (a) The calendar effect is the impact of working/trading days, fixed and moving holidays, leap year and other calendar related phenomena (e.g. bridging days) on a time series. The calendar effect can be divided into a seasonal and a non-seasonal component: the former corresponds to the average calendar situation that repeats each year at the same season; the latter corresponds to the deviation of the calendar variables (such as numbers of trading/working days, moving holidays, leap year days) from the long-term month- or quarter-specific average. The seasonal component of the calendar effect is part of the seasonal component of the series and removed by seasonal adjustment. The non-seasonal part of the calendar effect is called the “calendar effect component” and adjusted for by calendar adjustment as defined in the following recommendations.

[amended recommendation]

- (b) Calendar adjustment removes those non-seasonal calendar effects (the calendar effect component) from the series, for which there is statistical evidence and an economic explanation. Calendar effects, for which a series are adjusted for, should be identifiable and sufficiently stable over time or, alternatively, it should be possible to model their changing impact over time appropriately. In order to ensure that the estimated calendar component is sufficiently stable over time, the selection of relevant calendar effects used for calendar adjustment should be kept constant over appropriately long time periods, even if the value of statistical indicators might be at the border of the significance threshold. Changes in the selection of calendar effects should be based on both empirical evidence and economic explanation.

Calendar adjustment should include working/trading day adjustment, moving holiday adjustment as well as a removal of leap year effects. The length of a moving holiday effect (e.g. Easter) should be tested and appropriately adjusted for. The adjustment for other effects, such as effects related to the weather, school holidays etc. should not be done. However, it might be useful to model these effects in order to improve the estimate of the seasonal and calendar component if there is clear statistical evidence and if sufficient and sound information is available. Other pre-adjustments (outliers and intervention variables) should be carried out to improve the estimate of the seasonal and calendar component. The modelling of these effects should be based either on information directly available or estimated in a regression framework.

[amended recommendation]

- (c) In order to obtain accurate estimates of the seasonal component, the calendar adjustment should be performed prior to the seasonal adjustment.

[basically unchanged recommendation]

- (d) The regression approach with ARIMA-based error modelling is recommended for calendar adjustment. Where more appropriate information is available, a direct correction of the raw data for calendar effects may be made. Proportional methods should not be used.

[unchanged recommendation]

- (e) QNA data should be calendar adjusted. The adjustment should be made for those variables for which there is a statistical evidence and economic explanation of calendar effects. When deciding whether or not to apply a calendar adjustment to QNA data consideration has also to be given to the QNA accounting coherence and stability over time of the parameter estimates.

[amended recommendation]

- (f) Purely calendar adjusted data should be compiled in order to enable the analysis of the impact of the non-seasonal calendar effect. Equivalent relevant information should be made available, if the compilation of pure calendar adjusted series is technically not feasible. Information about calendar adjustment should be provided in the metadata template on seasonal adjustment. Pure calendar adjusted data covers according to the ESA95 transmission programme at least Gross Domestic Product and total Gross Value Added and, on a voluntary basis, all the other items in Table 1.

[new recommendation]

- (g) For calendar adjustment the following could be used to improve the accuracy of results:
- multiple regressors, for example the split of regressors for certain periods of the year or weekdays when there is evidence that the estimated parameters differ;
 - different regressors for different series (e.g. output and consumption);
 - derivation of quarterly calendar factors from monthly indicator/source series;
 - derivation of calendar factors for QNA aggregate series from QNA component series or from indicator component series.

[basically unchanged recommendation]

- (h) Calendar adjustment based on quarterly indicators or direct adjustment of quarterly national account components should be limited to the cases in which source data at higher (monthly) frequency are not available or not suitable for this purpose.

[amended recommendation]

- (i) National calendar regressors should be used in the calendar adjustment to ensure more accurate results, taking into account national and regional holidays if they may have a significant impact on the national result. Indicator/sector/industry-specific calendar regressors should be used, whenever it leads to a significantly improved accuracy of calendar adjustment.

When a direct approach is chosen for the seasonal adjustment of European aggregates, the use of European calendar regressors obtained by aggregating, according to a weighting scheme, country-specific calendar regressors can be considered, in particular if national calendar adjusted series are not available, incomplete or of insufficient statistical quality. The use of a calendar regressor that does not reflect country-specific holidays and working-day patterns, and their differences, should normally be avoided.

[amended recommendation]

- (j) All the effects estimated in the pre-adjustment phase should be clearly identified as separate components of the raw series. The final calendar adjusted series should only remove the working/trading-day component as well as moving holiday and leap year effects. The final calendar and seasonally adjusted series should exclude in addition only the seasonal component.

[basically unchanged recommendation]

7.3 Recommendation for seasonal adjustment of QNA, in particular of chain-linked QNA volume measures¹³

- (a) QNA may be compiled according to two main approaches (see also ESA95 para. 12.04), a “direct approach” based on the availability at quarterly intervals, with appropriate simplifications, of the similar sources as used in the annual accounts, or an “indirect approach” based on time series disaggregation of the annual accounts with statistical models using indicator series at monthly or quarterly frequency. While most of the recommendations on seasonal adjustment apply to both approaches, specific guidance for QNA compiled according to the indirect approach are outlined in recommendation (o).

[new recommendation]

- (b) Seasonality is defined as any pattern that repeats on a regular basis in the same quarter each year. Adjusting for seasonality removes the identifiable regular repeated influences, but not the impact of any irregular events. Seasonality includes the length of month/quarter effect.

[unchanged recommendation]

- (c) A generally applicable choice between indirect and direct adjustment of quarterly national accounts is not possible. Case-by-case decisions are necessary, taking into account the achievable gain in accuracy by an indirect adjustment.

[unchanged recommendation]

- (d) Seasonal factors should be updated whenever (significant) revisions in raw data occur and may be updated when a new observation becomes available (concurrent adjustment). In order to reduce the frequency of revisions, projected factors for a period of up to one year may be used. In this case, their quality should be checked every quarter against a concurrent adjustment.

[unchanged recommendation]

- (e) To limit the amount of revisions in concurrent adjustments (especially when a model-based approach is used), the form of the models should be re-specified only on a yearly basis while parameters may be estimated concurrently, except where a known or unusual event requires intervention.

[unchanged recommendation]

¹³ The following recommendations are generally in line with chapter 16 of the preliminary draft of 1993 SNA Rev1, in particular paragraphs 16.46, 16.48, 16.50 and 16.62.

- (f) The compilation of seasonal and calendar adjusted QNA chain-linked volume measures is the result of a sequence of operations including seasonal and calendar adjustment, chain-linking, benchmarking and balancing, applied to the available basic or aggregated information.

[new recommendation]

- (g) Unadjusted QNA volume measures in average prices of the previous year shall be chain-linked, followed by a benchmarking of the chain-linked series to the independently derived annual totals. Seasonally adjusted chain-linked QNA volume measures shall be obtained by adjusting the chain-linked series, followed by a benchmarking of the adjusted chain-linked series (see recommendation (j)). Calendar adjustment may be conducted for indicator series used as sources for QNA at monthly or quarterly frequency, in particular if calendar effects can be identified and estimated more straightforwardly for indicators.

There are QNA compilation systems in which seasonally adjusted data are produced at a very detailed level, and even at a level at which no chain-linking is applied (e.g. when producing QNA from quarterly supply and use tables). The order applied in this case is seasonal adjustment, balancing, chain-linking and benchmarking. Since at a disaggregated level the estimates of the seasonal component might not be as reliable as at higher QNA aggregation levels, particular care is needed as regards revisions of the seasonal component. Furthermore, balancing and chain-linking seasonally adjusted data must not introduce a seasonal pattern into the series.

[new recommendation]

- (h) QNA volume measures in average prices of the previous year can be chain-linked by using the one-quarter-overlap, the annual-overlap or the over-the-year technique. From the perspective of seasonal adjustment of QNA volume measures, the one-quarter-overlap and the annual-overlap technique are preferred. The over-the-year technique is not recommended as it may introduce breaks in every single quarter-on-quarter movement of the series, which might impact on the meaningfulness of quarter-on-quarter changes, whose provision in seasonally adjusted form is of key importance for economic analysis.

[new recommendation]

- (i) Unadjusted chain-linked QNA volume measures (or unadjusted indicator series) should be consistent with independently derived chain-linked annual volume measures.¹⁴ This is the case for the annual-overlap technique. For results calculated using the one-quarter-overlap or the over-the-

¹⁴ ESA 95 para 12.06 requires: “Since quarterly accounts adopt the same framework as annual accounts they have to be consistent over time with them. This implies, in case of flow variables, that the sum of the quarterly data is equal to annual figures for each year.”

year technique (to a lesser extent) this is not the case. The use of benchmarking techniques is therefore recommended when the one-quarter-overlap or the over-the-year technique is applied. A benchmarking technique which minimises the impact on the quarter-on-quarter changes of the series should be chosen.

[new recommendation]

- (j) Seasonally adjusted chain-linked quarterly volume measures should be made consistent to the respective non-seasonally adjusted chain-linked annual data by using a benchmarking technique which minimises the impact on the quarter-on-quarter changes of the series. The benchmarking is required for purely practical reasons, e.g. the consistency of annual average growth rates. Benchmarking must not introduce a seasonal pattern into the series. The reference should be the independently derived chain-linked annual series in unadjusted form for only seasonally adjusted QNA, and in calendar adjusted form for seasonally and calendar adjusted QNA. The calendar adjusted chain-linked annual series may be derived by applying a calendar factor derived from calendar adjusted quarterly or monthly data. If it can be shown that calendar effects on the annual chain-linked series are systematically negligible, the reference for benchmarking the quarterly seasonally and calendar adjusted series may be the independently derived chain-linked annual series in unadjusted form.

Exceptions from the desired time consistency may be acceptable if the seasonality is rapidly changing. Calendar adjusted quarterly data should not be benchmarked to unadjusted annual data since the number of working days may differ across calendar years.

[amended recommendation]

- (k) Chain-linked volume measures in unadjusted and adjusted form are not additive.¹⁵ No correction should be made to remove the non-additivity introduced by chain-linking.

QNA volume measures in average prices of the previous year should be additive. If for data in average prices of the previous year differences between the non-adjusted total GDP and the aggregate of its non-adjusted (expenditure or output) components arise, these should be allocated to a series of statistical discrepancies which is transmitted to Eurostat. Alternatively, the discrepancies could be allocated to a series which typically has a residual character (e.g. changes in inventories) or could be distributed among the components. In the latter case the effect on the pattern of the non-seasonally adjusted series should be minimised.

[amended recommendation]

¹⁵ “Additivity ... implies that at each level of aggregation the volume index for an aggregate takes the form of a weighted arithmetic average of the volume indices for its components with base-period values as weights.” (Source: 1993 SNA, Paragraph 6.55).

- (l) As for volume measures with a fixed price-base year, there is a choice between indirect and direct seasonal adjustment of QNA volume aggregates for chain-linked measures.¹⁶ Indirect adjustment of chain-linked volume measures means that the adjusted chain-linked aggregate is obtained by aggregating the adjusted component data in average prices of the previous year¹⁷ and chain-linking the result.

The seasonally adjusted data in average prices of the previous year should be derived by unchaining the benchmarked adjusted chain-linked volume series. Discrepancies between the seasonally adjusted total GDP and the aggregate of its seasonally adjusted components expressed in average prices of the previous year which arise due to the direct adjustment of the total GDP should be allocated to a series of statistical discrepancies which is transmitted to Eurostat. Alternatively, the discrepancies could be allocated to a series which typically has a residual character (e.g. changes in inventories) or could be distributed among the components if the annual overlap approach is applied. In such cases the series affected by the distribution should be checked for residual seasonality.

[amended recommendation]

- (m) Deriving seasonally adjusted values in average prices of the previous year from benchmarked seasonally adjusted chain-linked volume measures does not require any additional information to those data anyway provided in the ESA95 transmission programme, when the annual overlap method is applied, whereas the other chain-linking methods require additional data for unchaining the adjusted chain-linked series.

According to Regulation (EC) No 1392/2007, the transmission of adjusted QNA volume measures to Eurostat shall include adjusted data in average prices of the previous year. The data are used by Eurostat to validate the consistency in aggregation of the data provided by countries and to calculate European aggregates. The transmission is strictly necessary for countries not using the annual overlap technique for chain-linking. When the annual overlap technique is used it is generally straightforward to derive adjusted data in average prices of the previous year from adjusted chain-linked data. In these cases Eurostat may inform to which extent the transmission of adjusted data in average prices of the previous year is required, taking into account the possible reduction of the reporting burden.

[new recommendation]

¹⁶ Generally, the choice between indirect and direct seasonal adjustment requires case-by-case decisions, taking into account the statistical quality achievable by direct or, alternatively, indirect adjustment and the user requirement for consistency.

¹⁷ It has to be noted, that unchaining leads in principle to data which are unrelated across years. A comparison of these data across years may show a seasonal pattern between the fourth quarter of one year and the first quarter of the following year, even if the data in prices of the previous year are derived from seasonally adjusted chain-linked series.

- (n) A QNA volume measure which is derived from component series or as residuals may have zero or negative values, although each of its components is strictly positive (e.g. external balance, changes in inventories). For these series chain-linking is not possible. Seasonally adjusted data should be calculated by aggregating the seasonally adjusted data of the strictly positive component series expressed in average prices of the previous year. The seasonally adjusted data of the strictly positive components shall be derived from the seasonally adjusted and benchmarked chain-linked component series.

[new recommendation]

- (o) In several Member States unadjusted or adjusted QNA series are compiled according to the "indirect" approach that derives quarterly time series from annual aggregates by applying temporal disaggregation techniques using unadjusted or adjusted indicator series. Therefore, the order of procedure for chain-linking, benchmarking and seasonal adjustment may differ from the order outlined before. In these cases procedures should be applied that lead to adjusted QNA volume measures that are comparable to the QNA measures produced according to the recommendations above. In particular the following applies:

- In principle, temporal disaggregation techniques should not be applied to annual data expressed in average prices of the previous year. These series might present breaks from one year to the other (due to the shifting of the price base year). Rather, disaggregation techniques should be applied to chain-linked annual series. Volume indicators with a fixed price-base year can be used when chain-linked indicators are not available.
- Temporal disaggregation can be applied using unadjusted indicator time series for deriving unadjusted QNA data. Temporal disaggregation techniques can also be applied using seasonally adjusted indicators for deriving seasonally adjusted QNA data. In these cases the recommendations 5 to 11 should be applied analogously.

[new recommendation]

Annex 1: Calendar effects and calendar adjustment – Draft glossary

Calendar effect

The calendar effect is the impact of working/trading days (number and composition), fixed and moving holidays, leap years and other calendar phenomena (e.g., bridging days) on the time series under review.

The calendar effect resumes periodical effects on a time series which are, directly or indirectly, linked to specific calendar situations. While the Christmas effect on economic activity is always caught by the month of December/fourth quarter (therefore it is to a large extent assigned to the seasonal component), the effect of Easter, as well as other moving holidays, may concern varying months or quarters (Catholic Easter can affect March or April, i.e. the first or the second quarter). For this reason, moving holiday effects require a special statistical treatment.

A special calendar correction is the leap year correction.

The calendar effect is normally caught via a quantitative estimation of the effect on the value of a quarterly or monthly time series in a quarter or month, e.g. measured by estimating the effect of the deviation in the number of working days from its long-term average in that quarter or month.

The calendar effect can be divided into a seasonal and a non-seasonal component: the former corresponds to the average calendar situation that repeats each year at the same season; the latter corresponds to the deviation of the calendar variables (such as trading/working days, moving holidays, leap year) from the monthly or quarterly specific long-term average.

Calendar effect component

The calendar effect component is an estimate of the non-seasonal calendar effect, for which there is statistical evidence and an economic explanation.

Calendar adjustment

The calendar adjustment is the removal of the calendar effect component.

Working day/trading day adjustment

Working day or trading day adjustments refer to the removal of the non-seasonal effect related to the number and the composition of working or trading days in a given month/quarter for flow series or the sort/type of day for stock series.

Each month and quarter embody a varying number of Mondays, Tuesdays, ... and Sundays and, consequently the business activity can vary accordingly. The working day effect catches the difference between the “working-days” (i.e. Monday, Tuesdays,..., Friday) and the weekend days

(Saturday and Sunday) according to the idea that these two groups of days have different effects. The trading day effect catches the difference between the days of the week.

In practice, trading day adjustment and working day adjustment are often used as synonyms. However, this approach is not followed here. Instead, the above mentioned difference in terminology is used.

Public holidays

A public holiday (also known as "general", "statutory" or, in United Kingdom and Ireland, "bank" holiday) is a holiday established and regulated by national, regional or local authorities.

Fixed holidays

Fixed holidays are holidays which occur each year, at a fixed date (e.g. Christmas).

Moving holidays

Moving holidays are holidays which occur each year, but at varying dates (e.g. Catholic Easter).

Regional holidays

Regional holidays are public holidays established and regulated by regional authorities.

At country level, regional holidays are not to be treated as full holiday but only as partial holidays (according to the share that the data for the regions affected by the holiday customarily take up in the total result for the country).

National holidays

National holidays are public holidays established and regulated by national authorities.

At European level, national holidays, which are not established in all counties within Europe, are not to be treated as full holiday but only as partial holidays (according to the share that the data for the country affected by the holiday customarily take up in the total result for the European Union).

Regional calendar and regional calendar regressors

Regional calendars are the collection of fixed and moving holidays, working/trading days at regional level.

Regional calendar regressors reflect the regional calendar situations for calendar adjustment purposes in terms of numbers of working/trading days, holidays etc.

National calendar and national calendar regressors

National calendars are the collection of fixed and moving holiday, working/trading days at national level.

National calendar regressors reflect national calendar situations for calendar adjustment purposes in terms of numbers of working/trading days, holidays etc. National calendar regressors may be built from weighted averages of regional calendars regressors.

European Union/euro area calendar and European Union/euro area calendar regressors

EU/EA calendars are the collection of fixed and moving holidays, working/trading days at European Union/Euro area level.

EU/EA calendar regressors reflect the EU/EA calendar situations for calendar adjustment purposes in terms of numbers of working/trading days, holidays etc. EU/EA calendar regressors are usually built from weighted averages of national calendars regressors.

Specific indicator/sector/industry calendars

European/national/regional specific indicator/sector/industry calendars are the collection of fixed and moving holidays as well as trading/working days at national level related to a specific indicator/sector/industry.

The number of working or trading days in a given month or quarter can vary significantly for each statistical domain (e.g. production, merchandise trade) because of differing institutional arrangements, trade specific holidays, etc.

Bridging days

Bridging days are days (up to two) lying between a public holiday and a weekend.

Bridging days may generate effects on the time series under review. These result from people taking holidays on bridging days.

School holidays

School holidays are periods in which classes are not given.

The economic activity in a month/quarter is likely to be affected by the schedule of the school holidays. Workers with school-age children take leave above all during the school holidays, and hence interrupt their work.

Weather effects

Weather effects are effects that are linked to specific weather conditions. If they do not occur repeatedly with the exact same intensity in the same month of each year they contain a non seasonal effect.

Non seasonal weather effects are associated with exceptional/atypical weather conditions. Weather effects can affect different economic activities in a different way (for example, construction, tourism services).

Annex 2: Contributions to growth

In the dissemination of Quarterly National Accounts, contributions to GDP growth play a prominent role. Indeed, they measure the impact of the growth of a component on the growth of an aggregate, from an accounting point of view. Hence, they are an essential tool to analyze how different components affect the growth of GDP. The Task Force decided to review different techniques available to compute contributions to growth from chain-linked data¹⁸, concluding that further work in this area is needed before reaching any conclusion.

With the introduction of chain-linking, volume measures are not additive, and the computation of contributions is not as straightforward as it used to be. Unless otherwise specified, the formulae presented hereafter are based on an annual overlap chain-linking technique.

The additive case

In the case of additive volume measures (noted *Add*), the formula of contributions from an element (X_i) to an aggregate (X) is straightforward:

$$C(X_i^{Add}, X^{Add})_{a,t} = \frac{\Delta X_{i,a,t}^{Add}}{LX_{a,t}^{Add}} = \frac{LX_{i,a,t}^{Add}}{LX_{a,t}^{Add}} \frac{\Delta X_{i,a,t}^{Add}}{LX_{i,a,t}^{Add}} = \frac{X_{a,t}^{Add} - LX_{a,t}^{Add}}{LX_{a,t}^{Add}} - \frac{(X_{a,t}^{Add} - \Delta X_{i,a,t}^{Add}) - LX_{a,t}^{Add}}{LX_{a,t}^{Add}}$$

where L is the lag operator, $\Delta = 1 - L$ the difference operator, $X_{i,a,t}^{Add}$ the *Add* measure of the component in quarter t of year a and $X_{a,t}^{Add}$ the measure of the aggregate X at quarter t of year a .

This additive contribution can be expressed in three ways:

- the first one is the ratio of the increase in the component to the lag of the aggregate.
- the second one is expressed as the growth rate of the component, weighted by its share in the aggregate in the previous quarter¹⁹.
- the third one interprets the contributions to growth as partial contributions. The basic idea can be illustrated with an example: The contribution to GDP growth made by net exports can be expressed as the difference between GDP growth and the aggregate of zero growth in net exports and the change in domestic demand. The 0.5 percentage point contribution to GDP growth made by net exports thus tells that GDP, *ceteris paribus*, would have grown by 0.5 percentage point less if net exports had not changed. The corresponding formula is the result of some simple mathematical transformations.

¹⁸ The list of methods reviewed is not exhaustive. It does not cover for example the situation where the adjustment is done independently to all the variables without any further reconciliation process.

¹⁹ Note that the sum of the weights over the components of an aggregate is unity, given additivity of the measure.

The first one decomposes the increase in the aggregate as the sum of its components' increases, whereas the second one expresses the growth rate of the aggregate as the weighted average of its components' growth rates. The third one gives a direct interpretation of the contributions to growth as partial contributions. The equivalence between all approaches is due to the additivity of the measure.

Non-additive measures

However, chain-linked volumes are not additive, and the above formula does not yield satisfying results when applied on chain-linked volumes. To the knowledge of the task force, no less than six different formulae have been proposed.

Following the three expressions of the additive contribution formula, one can classify the different methods into two broad categories: the first uses weighting systems to weight the components' growth rates; the second transforms chain-linked measures into an additive measure to compute contributions; the third is based on the partial contribution concept.

At this point, the notion of additivity for contributions must be properly defined. A contribution formula is additive if the sum of contributions from two separate components to an aggregate equals the contribution of its sum to the aggregate (*e.g.* contribution from households' consumption to GDP equals the sum of the contributions of households expenditures on goods and households consumption of services to GDP). In particular, for any decomposition of an aggregate, the sum of the contributions from its components equals the aggregate's growth rate.

For the sake of clarity, some notations will be introduced: the measures of a given aggregate X at quarter t of year a will be denoted $X_{a,t}^{CuP}$ in current prices, $X_{a,t}^{PYP}$ in previous year prices and $X_{a,t}^{CLV}$ in chain-linked volumes. Its price deflator will be $P_{a,t}^X = \frac{X_{a,t}^{CuP}}{X_{a,t}^{CLV}}$. Measures indexed by a year denote annual data (*e.g.* X_a^{CuP} is the current price volume measure of aggregate X in year a and $P_a^X = \frac{X_a^{CuP}}{X_a^{CLV}}$ is the average deflator of X in the same year).

1. Weighted Growth Rates (WGR)

Weighted growth rates are very attractive for their simplicity of use and because they are independent of the quarterly linking technique. Indeed, contributions in this framework are easily computed and their relationship to the elements' growth rate is very simple. Anyway, these contributions formulae are not additive: the sum of contributions from two separate components to an aggregate does not equal the aggregate's growth rate.

a. Annual weighting system

In this approach, contribution from a component to an aggregate is expressed as:

$$Contrib.WGR_A(X_i, X)_{a,t} = \frac{X_{i,a-1}^{CuP} \Delta X_{i,a,t}^{CLV}}{X_{a-1}^{CuP} LX_{i,a,t}^{CLV}}$$

The weighting system is that of the previous year current prices measure.

b. Quarterly weighting system

In this alternative, the weighting system is that of the previous quarter at current prices.

$$Contrib.WGR_Q(X_i, X)_{a,t} = \frac{LX_{i,a,t}^{CuP} \Delta X_{i,a,t}^{CLV}}{LX_{a,t}^{CuP} LX_{i,a,t}^{CLV}}$$

2. Contribution of growth based on transformed data

a. Previous year prices

This family of contributions formulae takes advantage of the additivity of measures in previous year prices except in one case. Indeed, when such data are available, they are additive. However, the growth rates for chain-linked aggregates and for aggregates in previous year prices can differ from year to year (but not within a year). Therefore, an additive decomposition of growth rates based on data in previous year prices does not imply an additive decomposition of growth rates for chain-linked figures from year to year (but within a year).

$$Contrib.PYP(X_i, X)_{a,t} = \frac{P_{a-1}^{X_i} \Delta X_{i,a,t}^{CLV}}{P_{a-1}^X LX_{a,t}^{CLV}}$$

b. Additive Volume Data (AVD)

This method exploits the additivity of volume measures in the year following the reference year. Therefore, if we want to calculate quarter-on-quarter or year-on-year growth contributions for the quarters of year T, we should reference the volume estimates for the quarters of year T-1 and T to year T-1. It should be noted that not all the series have to be referenced to every single year. For calculating quarter-on-quarter and year-on-year growth contributions it will suffice to reference only 8 quarters to a given reference year. This method is independent of the linking technique.

c. French QNA (FQNA)

French QNA uses a formula that is based on the PYP approach, but which extends additivity to the first quarters. The formula is the following:

$$\begin{aligned} \text{Contrib.FQNA}(X_i, X)_{a,t} = & \text{Contrib.PYP}(X_i, X)_{a,t} \\ & + \delta_{t=1} \cdot \left(L \frac{X_{i,a,t}^{CLV}}{X_{a,t}^{CLV}} - \frac{X_{i,a-1}^{CLV}}{X_{a-1}^{CLV}} \right) \cdot \left(\frac{P_{a-1}^{X_i}}{P_{a-1}^X} - \frac{P_{a-2}^{X_i}}{P_{a-2}^X} \right) \end{aligned}$$

where $\delta_{t=1} = 1$ if $t = 1$ and 0 otherwise : the second term only shows up for first quarters. This last term, which ensures additivity at a global level, is of a second order of importance²⁰. Note that since year changes do not jeopardize additivity in this formula, additive contributions to year on year changes can also be derived.

3. Partial Contributions to Growth (PCG)

The Bundesbank proposed an elegant way to compute contribution. The contribution to GDP growth of a component is calculated as the difference between GDP growth and the growth obtained assuming that the component has not changed. This idea and its formulae can both be applied to chain indices (also in a Fisher index environment). However, instead of using simple sums and differences the rules for aggregating and disaggregating chained indices have to be applied. This is done in Germany based on an excel macro which is free of charge available from the Deutsche Bundesbank.

The formula used is directly derived from the third interpretation of the contributions to growth. Therefore, the results can always be interpreted as partial contributions. This concept fulfils additivity within a year but not between years, like the annual overlap technique.

Relations between the different approaches

When an annual overlap chain-linking technique is used, the following relations hold:

$$\begin{aligned} \text{Contrib.PYP}(X_i, X)_{a,t} &= \frac{\left(\frac{P_{a-1}^{X_i}}{P_{a-1}^X} \right)}{L \left(\frac{P_{a,t}^{X_i}}{P_{a,t}^X} \right)} \text{Contrib.WGR}_Q(X_i, X)_{a,t} \\ &= \frac{L \left(\frac{X_{i,a,t}^{CLV}}{X_{a,t}^{CLV}} \right)}{\left(\frac{X_{i,a-1}^{CLV}}{X_{a-1}^{CLV}} \right)} \text{Contrib.WGR}_A(X_i, X)_{a,t} \end{aligned}$$

$$\text{Contrib.PYP}(X_i, X)_{a,t} = \text{Contrib.PCG}(X_i, X)_{a,t}$$

²⁰ Indeed, it is the product of two growth rates.

Hence, substantial differences exist between the two weighting systems that may be used in the weighted growth rates approach, depending on the frequency at which the weights are computed:

- when weights are computed using quarterly data only, the deviation from the PYP contribution depends on the change of the relative price deflators of the element and the aggregate between the last quarter and previous year;
- when annual weights are used, this deviation depends on the change in the ratio of CLV measures between the same periods.

Since relative prices are much more volatile than volume ratios, one can expect the annually weighted growth rates formula to deliver results that are closer to PYP formulae, and therefore closer to additivity within a year.

Terms of the choice between formulae

Although all the methods provide similar results there are some aspects that might be taken into account when choosing a method.

a. Comparability of the results

From this point of view methods PYP, PCG, AVD and FQNA²¹ seem provide almost exactly the same results while the results obtained with WGR are not comparable. This criterion is especially relevant for International Organizations like Eurostat and ECB.

b. Independence from the choice of the linking technique

PYP, PCG and FQNA rely on the calculation of adjusted series expressed at average prices of the previous year. To obtain these series for data that have been linked using the annual overlap is relatively straightforward. This is not the case for series that have been chained with a different technique. In this sense, the methods WGR and AVD have the advantage to be applicable to chain-linked figures obtained by any linking technique.

c. User friendliness

Methods WGR, AVD or PCG are probably easier to explain to non-advanced users and they can be replicated by external users in a relative easy way (for the PCG with a free available excel macro developed by the Bundesbank). Nonetheless, user friendly tools could be developed for PYP and FQNA (INSEE has made available on its website²² an excel template that calculates contributions to growth using FQNA) that would allow the calculation of the growth contributions directly, partially hiding to non

²¹ Except for the first quarter quarter-on-quarter and for year-on-year contributions.

²² http://www.insee.fr/fr/indicateur/cnat_trim/Pub_Meth/Contributions.xls

specialist users the relatively complex steps to be taken. On the other side, advanced users might prefer the PYP, PCG and FQNA approaches, as they permit custom aggregations (and their contributions to growth), as far as the annual overlap technique has been used.

d. Additivity

Only the FQNA approach produces additive contributions, which could be an important criteria when some contributions are calculated by difference, for example change in inventories. Nonetheless, at the level of QNA aggregates the non-additivity of the other approaches is almost negligible. Of course, for more detailed breakdowns displaying volatile price changes the non-additivity may become an important drawback.

e. Interpretability

It would be interesting to interpret the contributions to growth in a direct way, like in the partial contributions to growth concept.

Annex 3: Seasonal adjustment factors for main QNA components and selected countries²³

VALUE ADDED

Value added NACE C-E					Value added NACE G-I				Value added NACE J-K			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
EU25	100.7	100.1	96.3	103.1	96.8	100.4	101.2	101.6	98.9	99.7	99.0	102.4
CZ	101.7	103.4	93.8	101.7	92.8	107.6	103.0	98.7	99.2	100.6	94.3	105.3
EE	99.3	100.2	96.2	104.2	94.4	103.8	103.0	108.4	99.7	101.5	98.3	100.6
HU	95.6	99.4	98.6	106.2	87.3	101.4	102.6	108.4	93.7	100.5	98.6	106.9
SK	103.9	102.2	97.2	97.0	92.4	112.6	108.8	85.9	106.5	98.5	99.7	95.2
FI	95.9	101.6	99.8	101.8	94.9	100.9	101.4	103.0	97.4	100.6	97.3	104.7
SE	103.8	102.4	88.5	105.1	95.1	102.5	96.7	105.7	98.9	103.0	95.3	102.7

HOUSEHOLD AND GOVERNMENT FINAL CONSUMPTION

Household consumption					Government consumption			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
EU25	97.2	99.4	100.3	103.1	99.2	100.2	98.1	102.6
BE	98.8	101.6	98.9	101.6	100.0	100.0	100.0	100.0
DE	96.7	99.5	100.0	103.8	98.3	98.2	98.8	104.6
ES	87.8	101.3	99.8	110.8	98.5	98.3	98.5	104.5
FR	99.8	99.1	98.4	102.7	100.1	100.9	97.8	101.2
IT	99.1	98.9	103.5	98.5	98.6	100.0	99.5	101.9
NL	99.2	100.6	100.5	99.7	96.1	107.7	94.3	101.8
GB	96.6	98.5	101.3	103.6	100.1	99.5	99.7	100.7

GROSS FIXED CAPITAL FORMATION AND VALUE ADDED IN CONSTRUCTION

Gross fixed capital formation					Value added construction			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
EU25	93.2	101.0	98.1	107.5	88.8	101.9	103.2	105.6
LT	75.9	100.3	108.5	113.5	64.2	100.6	123.6	110.5
MT	93.5	104.7	97.9	104.3	n.a.	n.a.	n.a.	n.a.
AT	80.1	102.1	106.8	109.2	65.6	104.4	115.5	114.1
PT	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

²³ Adjustment factors are calculated as average ratios of published unadjusted data and seasonally (and calendar adjusted) data (*100) for the period from 1995 to 2006 (or as available), using data provided by Eurostat. For the purpose of cross-country comparisons all seasonal and calendar factors are presented as multiplicative components. A value of 100 indicates that there is no seasonal (calendar) effect adjusted for. A value of, for example, 120 indicates that the unadjusted series exceeds the adjusted series by 20%, a value of 80 indicates that the unadjusted series is 20% lower than the adjusted series.

Annex 4: Metadata template

SEASONAL ADJUSTMENT METADATA TEMPLATE Quarterly National Accounts (QNA) - Main Aggregates <i>(note: for metadata on employment, employees and hours worked see separate template)</i>		
<i>LINK TO GUIDELINES / GLOSSARY</i>		
Group of series : ESA 95 Transmission Programme Table 1 <i><link to Tab.1 ESA 95 Transmission Programme (e.g. on Eurostat website)></i>		
Country/Institution		
Contact Person responsible for SA (not a generic contact point)	<i>name / institution / position</i> <i>phone / e-mail / fax</i>	
GENERAL INFORMATION LINK TO OTHER STRUCTURAL METADATA FOR THE ORIGINAL (RAW) SERIES <i><link to raw QNA metadata (e.g. SDDS metadata template)></i>		
Frequency (*)		
Published series / relevant series	<i>Number of series by level of breakdown and kind of adjustment</i>	
	<i>Kind of adjustment</i>	<i>Series</i>
	<i>Raw series</i>	<i>Tab. 1 except / plus</i>
	<i>Only calendar adjusted series</i>	<i>GDP and total value added (yes/no)</i> <i>Other (group or name of series)</i>
	<i>Other adjustments (e.g. outliers correction)</i>	<i>Group or name of series</i>
	<i>Only seasonally adjusted</i>	<i>Group or name of series</i>
	<i>Seasonally and calendar adjusted</i>	<i>Tab. 1 except / plus</i>
	<i>Trend-cycle</i>	<i>Group or name of series</i>
	<i>Others</i>	<i>Group or name of series</i>
	<i>(*) if the indicators are published at a quarterly level but are available at a monthly level, please indicate if the adjustment is made at monthly or at quarterly level</i>	
Method used	<i>Parametric (please specify)</i> <i>Non parametric (please specify)</i>	
Software used (please also specify the version)	<i>Software</i>	<i>Version</i>
Publications	<i>title of hardcopy</i> <i>on-line access source</i>	

CALENDAR ADJUSTMENT							
Frequency (**)							
Calendar adjustment (trading/working day adjustment incl. moving holidays effect) If the indirect approach is followed the weight of the series on the aggregate should be indicated. If the direct approach is followed the number of series could be sufficient	Series by level of breakdown and kind of adjustment (weight/number o series)						
	Kind of adjustment	GDP	Value added		Expenditures	Income	
			Total	...A6		Compen- sation[#]	Other
	<i>No calendar adjustment</i>						
	<i>Trading day/ working day (Indicate the kind of regressor used)</i>						
	<i>Moving holiday effect (indicate which)</i>						
	<i>Leap year effect</i>						
<i>Others</i>							
<i>([#]) Series on compensation and gross wages and salaries</i>							
No calendar adjustment	<i>Reasons: a priori decision not significant calendar effect other (specify)</i>						
Calendar used for trading day adjustment	<i>Country-specific (national holidays) vs. default calendars series-specific: applicable for all the series in this group(s) as opposed to all other groups in the reporting country</i>						
	<i>(**) if the indicators are published at a quarterly level but are available at a monthly level, please indicate if the adjustment is made at monthly or at quarterly level</i>						
OTHER PRE-ADJUSTMENT							
Detection and replacement of outliers (°)	<i>yes (which outliers: impulse, transitory changes, level shifts) / no</i>						
	<i>(°) In order to improve the seasonal and calendar effect estimate, not filtered out in the seasonally and/or trading day adjusted series.</i>						

SEASONAL ADJUSTMENT							
Model/filter selection	Number of series by level of breakdown, type of filter selection and decomposition						
	Type	GDP	Value added		Expenditures	Income	
			<i>Total</i>	<i>...A6</i>		<i>Compen- sation[#]</i>	<i>Other</i>
	<i>Manual</i>						
	<i>Automatic</i>						
<i>([#]) Series on compensation and gross wages and salaries</i>							
Seasonal adjustment decomposition	Number of series by level of breakdown, type of filter selection and decomposition						
	Type	GDP	Value added		Expenditures	Income	
			<i>Total</i>	<i>...A6</i>		<i>Compen- sation[#]</i>	<i>Other</i>
	<i>Additive</i>						
	<i>Log-additive</i>						
	<i>Multiplicative</i>						
<i>Other</i>							
<i>([#]) Series on compensation and gross wages and salaries</i>							
AGGREGATION							
Direct adjustment of each series / indirect adjustment of GDP and other aggregates via components	<i>In case of indirect approach: - indicate whether residual seasonality is checked - indicate from which level of detail you are starting the aggregation</i>						
Consistency / Identity between GDP and components	<i>Current prices</i>			<i>Volumes (in prices of the previous year, unchained)</i>			
	<i>Yes (please indicate how consistency is achieved) No</i>			<i>Yes (please indicate how consistency is achieved) No</i>			
Time consistency Quarterly/annual	<i>Yes (please specify: quarterly and annual raw data, quarterly calendar adjusted and annual calendar adjusted/raw data, quarterly seasonally adjusted and calendar adjusted and annual raw/calendar adjusted data) No</i>						
Consistency / Identity between production, expenditure and income side	<i>Current prices (production, expenditure and income side)</i>			<i>Volumes (production and expenditure side in prices of the previous year, unchained)</i>			
	<i>Yes (please indicate how consistency is achieved) No</i>			<i>Yes (please indicate how consistency is achieved) No</i>			
REVISIONS							
Model, filters, outliers, calendar regressors re-identification	<i>please describe the strategy adopted and specify the frequency of re-identification</i>						
Parameters / factors re-estimation	<i>please describe the strategy adopted and specify the frequency of re-estimation</i>						
Horizon for published revisions	<i>complete series limited time range (please specify)</i>						
QUALITY INDICATORS							
Please indicate all the quality measures used							

AVAILABILITY OF STRUCTURAL METADATA	
<i>Links to methodological reports</i>	
<i>Links to national calendars used (if any)</i>	
<i>Availability of detailed information sufficient to allow users to replicate the process:</i>	<i>yes / upon request / no</i>
- <i>all series</i>	<i>yes / upon request / no</i>
- <i>published series</i>	<i>yes / upon request / no</i>
- <i>other subsets (please specify)</i>	<i>yes / upon request / no</i>

Annex 5: List of participants

<u>Chairmen:</u>	Roberto Barcellan (meeting 3 and 4), Gian Luigi Mazzi (1 and 2) (Eurostat) Henning Ahnert (ECB)
<u>Secretaries:</u>	Luis Biedma (Eurostat) Martin Eiglsperger (ECB)
<u>Belgium:</u>	Isabelle Brumagne, Yves de Lombaerde (Banque Nationale de Belgique)
<u>Bulgaria:</u>	Elka Atanasova, Dimitar Dimitrov, (National Statistical Institute of Bulgaria)
<u>Czech Republic:</u>	Michal Široký (Czech Statistical Office)
<u>Germany:</u>	Robert Kirchner (Deutsche Bundesbank), Tanja Götzke, Stefan Hauf (Statistisches Bundesamt)
<u>Estonia:</u>	Mihkel Täht (Statistics Estonia)
<u>Greece:</u>	Kostas Papandreou (National Statistical Service of Greece)
<u>Spain:</u>	Alfredo Cristóbal, Ángel Cuevas, Leandro Navarro (INE)
<u>France:</u>	Antonin Aviat (INSEE)
<u>Italy:</u>	Carmine Fimiani, Marco Marini (ISTAT) Antonio Bassanetti, Riccardo Cristadoro (Banca d'Italia)
<u>Lithuania:</u>	Nomeda Bratčikovienė (Statistics Lithuania)
<u>Hungary:</u>	Klára Kondiné Anwar (Hungarian Central Statistical Office)
<u>Malta:</u>	Waldemar Galea (National Statistics Office)
<u>Netherlands:</u>	Reinier Bikker, Hao van Bui, Marcel van Velzen (Statistics Netherlands)
<u>Austria:</u>	Ursula Havel (Statistik Austria) Marcus Scheiblecker (WIFO)
<u>Portugal:</u>	Rui Branco (INE)
<u>Slovak Republic:</u>	Zuzana Páleníková (Statistical Office of the Slovak Republic)
<u>Finland:</u>	Faiz Alshail (Statistics Finland)
<u>Sweden:</u>	Sven Öhlén, Stefan Svanberg (Statistics Sweden)
<u>United Kingdom:</u>	Simon Compton, Nigel Stuttard (ONS)