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# SEASONAL ADJUSTMENT OF HARMONISED INDICES OF CONSUMER PRICES – MAIN FINDINGS OF AN ESCB TASK FORCE<sup>1</sup>

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## 1. Introduction

Changes in consumer prices are typically reported in terms of year-on-year rates of change, while month-on-month rates of change play a much less prominent role. Several press releases on consumer prices provide supplementary information about inflation compared with the previous month, but seasonally adjusted figures of the changes are hardly ever referred to. Exceptions are Statistics Canada's releases on consumer price indices and, most prominently, the US Bureau of Labor Statistics' report on consumer price inflation which presents the seasonally adjusted month-on-month rate of change as the headline figure.

Seasonally adjusted data are used within the European System of Central Banks (ESCB), which is composed of the European Central Bank (ECB) and the central banks of the euro area, to provide a valuable contribution to short-term analyses of changes in consumer prices as well as to forecasting inflation, given that year-on-year rates of change can be substantially affected by base effects, i.e. by constellations occurring one year earlier. In addition, the Harmonised Index of Consumer Prices (HICP) is a chain index linked over December of the previous year. This implies that month-on-month rates of change are not affected by changes in the weights from one year to the next, i.e. they reflect pure price changes, while annual weight updates have an impact on year-on-year growth rates. For analysing month-on-month changes a seasonal adjustment is particularly useful. Seasonally adjusted indices can also be used for deriving measures of underlying inflation.

For the euro area HICP, the ECB started compiling a seasonally adjusted time series in 2000, using the proposals elaborated by a Task Force on Seasonal Adjustment in 1999 and 2000<sup>2</sup> as a basis for the

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<sup>1</sup> This paper has been prepared for the 12th Ottawa Group Meeting to be held from 4 to 6 May 2011 in Wellington. It reports on the work and the findings of the "Task Force on Seasonal Adjustment of National Harmonised Indices of Consumer Prices". Comments to the final Task Force report were provided by Gary Brown, Friedrich Fritzer, Jarko Pasanen, Mario Porqueddu, Daniela Schackis and Stefan Schipper. The views expressed in this paper are those of the author and do not necessarily reflect the views of the European Central Bank.

adjustment procedures. Since then, refinements have been introduced, taking account of, e.g., changes in the seasonal profile of clothing and footwear and administration of electricity prices. As a basic principle, seasonally adjusted data of the euro area HICP are obtained by aggregating the seasonally adjusted series known as the main components (or “special aggregates”), i.e. price indices for unprocessed food, processed food, non-energy industrial goods and services while, for the time being, the energy price index has been added in unadjusted form. The components are those used in the narrow inflation projection exercise (NIPE) to which all euro area national central banks contribute. These projections are typically based on seasonally adjusted HICP component and subindices.

For ESCB-internal purposes, the ECB has also been compiling seasonally adjusted HICPs for EU countries. However, national HICP series are adjusted directly for seasonal movements, i.e. the adjustment does not refer to the main components of the respective HICP.

In order to improve the seasonal adjustment of national HICPs the ESCB Working Group on General Economic Statistics (WGGES) decided to set up a Task Force on seasonal adjustment of national HICPs. This report summarises the work of the Task Force and presents recommendations how the seasonal adjustment of HICPs should be implemented in practice.

## **2. Mandate, members and meetings**

The ESCB Working Group on General Economic Statistics mandated the Task Force to cover the following aspects:

- (i) Review existing proposals on the seasonal adjustment of HICPs; identify relevant proposals in the European Statistical System’s Guidelines on Seasonal Adjustment.
- (ii) Examine the weighting of seasonally adjusted HICP components for indirectly adjusting total HICPs.
- (iii) Identify HICP components which should be seasonally adjusted.
- (iv) Review and specify approaches for the identification and treatment of irregular and one-off effects, in particular due to changes in taxes and excise duties.
- (v) Analyse the existence and relevance of calendar effects in national HICPs; investigate methods of estimating and adjusting for such calendar effects.
- (vi) Perform comparison studies of seasonal adjustment with X-12-ARIMA and TRAMO-SEATS.
- (vii) Prepare a proposal for the implementation, maintenance and dissemination of information on national practices for the seasonal adjustment (metadata).
- (viii) Assess the pros and cons of the publication of adjusted national HICPs.
- (ix) Any other work or assignment by the WGGES relating to the seasonal adjustment of national HICPs.

Members of the Task Force came from the national central banks of the Czech Republic, Germany, Estonia, Greece, Italy, Austria, Poland and Slovakia. Furthermore, experts from the national statistical

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<sup>2</sup> The report of the 1999/2000 Task Force is available via: <http://www.ecb.int/pub/pdf/other/sama0008en.pdf>

institutes of Ireland and the United Kingdom reported to the Task Force about their work in the field of seasonal adjustment of consumer price indices. Eurostat participated as observer.<sup>3</sup> The Task Force was chaired by the ECB and held three meetings, in November 2009, in March and October 2010.

### **3. Starting point, basic principles and definitions**

The Task Force chose as starting point the seminal work of the 1999/2000 Task Force on Seasonal Adjustment of Monetary Aggregates and the euro area HICP and drew on the experience gained with the seasonal adjustment of the euro area HICP since 2000. In addition, the Task Force decided to take into account relevant recommendations laid down in the European Statistical System's (ESS) Guidelines on Seasonal Adjustment<sup>4</sup>. In terms of further practical experience, the Task Force also took note of the main elements in the approach to seasonal adjustment of the US Consumer Price Index. Furthermore, the delegate from the UK's Office for National Statistics explained to the Task Force the seasonal adjustment of the RPIY, i.e. the Retail Price Index excluding mortgage interest payments, some other items as well as the full and immediate impact changes in excise duties would have had.

As a basic principle, the 1999/2000 Task Force recommended to adjust the euro area HICP indirectly by aggregating the indices for unprocessed food, processed food, non-energy industrial goods, services and energy. The consistency of these components and the total seasonally adjusted HICP is considered an important property, given the role of the main components play in the analysis and projection of HICP inflation.

Existing proposals and guidelines served as references for setting a general framework for the seasonal adjustment of HICPs, while the Task Force's more concrete work focused on several detailed issues which had to be dealt with in a closer context of consumer price statistics, in particular related to the definition of HICP main components.

### **4. General aspects of the seasonal adjustment of HICPs**

The Task Force reviewed the indirect adjustment of total HICPs by aggregating seasonally adjusted price indices for unprocessed food, processed food, non-energy industrial goods, services, while deciding case-by-case whether or not to seasonally adjust the energy price index. The Task Force members discussed the results of some test calculations, conducting for the respective countries direct seasonal adjustments of the total HICPs. These calculations revealed several item-specific characteristics that justify an individual treatment in seasonal adjustment. For example, the participants from the Czech Republic, Poland and Slovakia found in some component series significant effects related to the entry into the European Union in 2004 which did not play a significant role in other subindices. The Task Force agreed that conducting the adjustment on the level of main components has advantages for seasonally adjusting HICPs, in particular for analytical and forecasting purposes. However, the Task Force did not identify strong arguments in favour of generally adjusting HICP subindices on a more detailed level than the main-

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<sup>3</sup> The list of participants can be found in the Annex.

<sup>4</sup> The ESS Guidelines on Seasonal Adjustment are available via:  
[http://epp.eurostat.ec.europa.eu/cache/ITY\\_OFFPUB/KS-RA-09-006/EN/KS-RA-09-006-EN.PDF](http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-09-006/EN/KS-RA-09-006-EN.PDF)

component level (e.g. the 4-digit level of breakdown). Several items on a more detailed level of breakdown have been or could be substantially affected by one-off effects forming an obstacle to the identification in due time of changes in the seasonal profile and have the potential to obscure the series' seasonal pattern. Nevertheless, seasonal adjustment of selected 4-digit indices can be justified and serve best user needs, as illustrated by the German delegate.

Recommendation 1:

*Seasonally adjusted series should be compiled for the total HICP and for its main components, provided that identifiable seasonality is present. In order to obtain consistency of the total HICP and its main components, it is recommended to seasonally adjust the total HICP indirectly, in principle, by aggregating main component series. Aggregating the directly adjusted HICP excluding food and energy and the directly adjusted total food index – potentially excluding tobacco -, while adding the price indices for energy - and potentially tobacco - in unadjusted form, is a viable option, if the seasonal profile of directly adjusted component indices can be reliably estimated.*

*Euro area HICPs are seasonally adjusted at the euro area level, i.e. they are not obtained by aggregating the respective national HICPs.*

Since the HICP is a chain index linked over December of the previous year, weights change on an annual basis. These changes of weights are relevant for any indirect seasonal adjustment of HICPs. Given the impact the index value in the link period may have on the resulting chain-linked index series, the Task Force discussed the potential effect of referring to a seasonally adjusted rather than an unadjusted value in the link periods. Based on an artificial data set, Jan Walschots (Eurostat) has demonstrated that chain-linking of unadjusted data and seasonally adjusted data can produce time series with a different trend level. In this example trend levels were identical when each weight was adjusted for the seasonality in its price component. However, practical experience in terms of adapting weights for the aggregation of seasonally adjusted chain-linked component indices is currently lacking. Neither in the US CPI nor in the euro area HICP significant differences in trend levels of the unadjusted and the seasonally adjusted series have been found, although the same weights have been used as for the aggregation of the unadjusted subindices. At a more detailed level of breakdown, however, where seasonality in the link periods might be more pronounced, the issue of weighting of seasonal adjusted indices seems to matter. A practical alternative to the adjustment of weights would be a benchmarking of indirectly adjusted aggregate chain series, by using a mathematical technique that forces trend levels of the unadjusted and the adjusted series to be the same, e.g. by applying adaptation factors to the indirectly adjusted series. This approach would be similar to benchmarking approaches applied to National Accounts chain-linked volume series.<sup>5</sup>

Recommendation 2:

*Trend levels of indirectly seasonally adjusted HICPs should be compared with the trend levels of the respective unadjusted HICPs. In case significant deviations are identified an adaptation of weights used*

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<sup>5</sup> However, national accounts follow a different chain linking concept than the HICP.

*in the aggregation of seasonally adjusted component indices should be considered. Alternatively, the trend level of the indirectly seasonally adjusted HICPs can be benchmarked to the trend level of the respective unadjusted series.*

The Task Force also discussed the direct adjustment of month-on-month rates of change for seasonal movements rather than deriving seasonally adjusted month-on-month rates of change from seasonally adjusted index level series. Experimental results of a direct adjustment of month-on-month growth rates of the Polish HICP illustrated that such an adjustment can produce sensible results. However, it was argued that the index level series is the more general statistical concept, from which several statistical measures, not only growth rates, but also estimates of medium-term and trend developments, may be derived. A second, and more important argument is that seasonal and calendar effects impact on price levels in certain months, while month-on-month rates of change would reflect the changes in these impacts of seasonal determinants on two consecutive months which might make it more difficult to identify and interpret seasonal fluctuations.

*Recommendation 3:*

*HICP index level series, rather than growth rates, should be adjusted for seasonal movements.*

The Task Force looked into the outcome of using of X-12-ARIMA and TRAMO-SEATS for the seasonal adjustment of a given HICP series. Task Force members conducted several comparisons of the results produced by the two programs. In several cases, the seasonal profile estimated by X-12 and TRAMO-SEATS turned out to be similar. However, the test calculations also unveiled a significant number of cases which deserve special attention since the results of standard seasonal adjustments with the two programs may differ substantially. Such differences can be interpreted as calling for a more fine-tuned adjustment which could benefit from the cross-checking of the X-12 estimates with the TRAMO-SEATS results, and vice versa, thereby investigating the feasibility of coming up with more similar results.

*Recommendation 4:*

*The implementation and the review of the seasonal adjustment of HICP indices should use the information obtained by using both X-12-ARIMA and TRAMO-SEATS; for the regular monthly production either X-12-ARIMA or TRAMO-SEATS may be used.*

Significant revisions caused by seasonal adjustment, i.e. by new estimates of the seasonal profile of a series, are typically related to changes of the filters used in X-12, newly identified outlier dummies or a new specification of the ARIMA model used in TRAMO-SEATS. While most users are well aware that the recent end of a seasonally adjusted time series may be more significantly affected by revisions, it is less straightforward to understand the reasons for revisions in backdata. This applies in particular to revisions of backdata referring to periods more than two or three years prior to the current reporting period which are purely caused by newly estimated seasonal factors. Revisions in backdata of time series

adjusted with X-12 related to changes in seasonal moving average filters tend to be relatively small as soon as symmetric filters are applied. Forecasted seasonal factors, if used appropriately, may also not imply higher average revisions. On the other hand, the Task Force took note of an example presented by the ECB of substantial revisions in an HICP series caused by a different set of outliers automatically identified by X-12. Revisions of similar magnitude could also be related to a new specification of the ARIMA model in TRAMO-SEATS. In terms of outlier treatment, the Task Force agreed that fixing the dates for which outlier dummies are identified and carefully checking newly identified outliers is a strategy which helps stabilise the impact outliers have on seasonal adjustment.

Taking due account of revisions in backdata when ARIMA models used in TRAMO-SEATS are newly specified is a more demanding issue. The Italian delegate shared with the Task Force the experience gained and the policy implemented in terms of revisions in TRAMO-SEATS. Overall, Banca d'Italia found that the seasonal signals identified in HICP main component indices, both for Italy and the euro area, have been broadly stable over time, so that revisions have been generally reasonably small. He also explained that shortening the time series in terms of the number of backdata considered may help compile more stable seasonally adjusted data when the noise component in the series is high compared with the signal related to seasonal movements. Overall, handling revisions in TRAMO-SEATS requires a broad investigation of the implications different ARIMA model specifications may have on the final outcome of seasonal adjustment.

Recommendation 5:

*Seasonal adjustment should be conducted according to a controlled current adjustment or partial concurrent adjustment, as defined in the ESS Guidelines on Seasonal Adjustment.<sup>6</sup>*

- *“Partial concurrent adjustment: The model, filters, outliers and calendar regressors are re-identified once a year and the respective parameters and factors re-estimated every time a new or revised data becomes available.*
- *Controlled current adjustment: Forecasted seasonal and calendar factors derived from a current adjustment are used to seasonally adjust the new or revised raw data. However, an internal check is performed against the results of the “partial concurrent adjustment”, which is preferred if a perceptible difference exists. This means that each series needs to be seasonally adjusted twice. [...] A full review of all seasonal adjustment parameters should be undertaken at least once a year and whenever significant revisions occur (e.g. annual benchmark).”*

*Revisions caused by re-estimated parameters, newly specified models and outliers should be monitored on a monthly basis or whenever a new specification is taken into consideration. Outliers, in particular level shifts and temporary changes, which have been identified to be significant, are meaningful from an economic perspective and make a difference in the respective seasonal factors should be fixed in terms of dating and type. When ARIMA models and seasonal moving-average filters are reviewed, choices should be preferred, ceteris paribus, which keep revisions in backdata reasonably small.*

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<sup>6</sup> See Eurostat (ed.): “ESS Guidelines on Seasonal Adjustment”, Luxembourg 2009, p. 20.

## **5. Seasonal adjustment of HICP main components**

### **5.1 Unprocessed food**

HICP unprocessed food indices typically show a pronounced seasonal pattern. The Task Force agreed that a direct seasonal adjustment of the unprocessed food index can be considered as the most straightforward option. However, treating price indices for fruit and vegetables separate from the other subindices could improve the statistical quality of the seasonally adjusted results and/or serve better user needs. In this case an indirect seasonal adjustment of the unprocessed food price index could be preferred.

From January-2011 on, the seasonal patterns of unprocessed food indices in some national HICPs have been affected by the requirements of the regulation on the treatment of seasonal items<sup>7</sup> which enters into force at that time. A change-over from, e.g., moving-average approaches to the treatment of seasonal food to methods required by this regulation can be expected to cause a pronounced break in the seasonal profile and may have the potential to become significant in the euro area HICP for unprocessed food.

#### *Recommendation 6:*

*The direct seasonal adjustment of the HICP unprocessed food index is considered to be the most straightforward option. However, seasonal adjustment of subindices could be conducted if seasonal profiles are better identifiable at that level of breakdown.*

*Where the entry-into-force of the regulation on the treatment of seasonal items causes a seasonal break in the HICP unprocessed food index, it is an option to combine the unprocessed food index with other main components and to conduct the seasonal adjustment at a higher level of aggregation, e.g. the total HICP excluding energy and tobacco.*

### **5.2 Processed food (including alcoholic beverages and tobacco)**

Italy reported about investigations on the seasonal adjustment of the Italian and the euro area HICP which indicated that the price index on processed food does probably not exhibit identifiable seasonality. By contrast, calculations for other countries as well as the ECB's seasonal adjustment practice provided evidence that seasonality might be identifiable in some country indices for processed food as well as in the euro area processed food index. It was, however, a common finding that the infra-annual pattern of the price index for tobacco, which is part of processed food, was primarily affected by changes in excise duties. Taking account of these changes in tobacco prices by means of level shift outliers set in the periods the changes in excise duties became effective did not leave identifiable seasonality in the outlier-adjusted series. Price indices for alcoholic beverages also show some significant effects of changes in excise duties. However, remaining infra-annual profiles did not allow the Task Force to draw a definite conclusion whether or not identifiable seasonality is present in price indices for alcoholic beverages. The same holds on a more general level for the processed food index excluding tobacco.

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<sup>7</sup> <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:103:0006:0009:EN:PDF>

Recommendation 7:

*The HICP processed food index excluding tobacco should be tested for the presence of identifiable seasonality. In case of concrete evidence for presence of identifiable seasonality, which might be derived at the level of subindices, e.g. price indices for bread, corn, dairy products and/or oils and fats, the processed food index excluding tobacco should be seasonally adjusted. Adjustment of subindices or the exclusion of the price index for alcoholic beverages are viable options. Otherwise, the total HICP processed food series should be left unadjusted.*

### **5.3 Non-energy industrial goods**

The seasonal pattern of the non-energy industrial goods index is driven by the sales prices for clothing and footwear. The coverage of sales prices in the price indices for clothing and footwear was broadened in the years 2001 and 2002 causing a seasonal break in the series. The implementation of the new regulation on the treatment of seasonal items (see footnote 7) also affected the treatment of sales prices for clothing and footwear in several national series, resulting in permanent change in the seasonal profile of the non-energy industrial goods series.

Price administration of goods, e.g. pharmaceuticals, may also impact on the infra-annual profile of the non-energy industrial goods index, e.g. when price to be paid by the consumers (i.e. net of reimbursement) increase from zero to some positive value. Level shift dummies should be used in such cases, provided that the estimated effects are statistically significant and have the plausible sign.

Recommendation 8:

*The non-energy industrial goods index should take account of the seasonal break due to changes in the methodology by seasonally adjusting the parts of the series before and after the seasonal break separately, e.g. by splitting the time series and applying the respective seasonal factors to the respective part of the series.*

### **5.4 Services**

The two main issues affecting the infra-annual profile of the HICP services series are calendar effects in the price indices for package holidays, accommodation services and passenger transport by air and changes related to price administration. In addition, a break in the infra-annual profile of the services series was related to the extension of the coverage of services from January 2000 on in the areas of health, education, social protection services and insurance.

The German delegate presented to the Task Force his work on calendar adjustment of price indices for package holidays, accommodation services and passenger transport by air. Moving holidays, in particular Easter, impact on the German HICP, establishing a calendar effect. On the other hand, Christmas is an example of a non-moving holiday for which changes in price collection practices in Germany impacted on the series' profile, imposing a break in the seasonal pattern. Significant calendar effects have been

estimated by means of dummies which have been individually created in order to reflect relevant calendar constellations, e.g. the number of vacation days, and their relevance for price collection.

Recommendation 9:

*Price indices for package holidays, accommodation services and passenger transport by air should be adjusted for identifiable calendar effects. The identification of calendar effects often requires detailed knowledge of the price collection practices (and how they may have changed over time); individually specified calendar regressors should be used for this purpose.*

*The seasonal adjustment should be conducted separately before and after the seasonal break by splitting the time series and applying the respective seasonal factors to the respective part of the series.*

*Care has to be taken that subindices of the services price index which are significantly affected by price administration do not adversely impact on the estimation of seasonal patterns. Supplementary information, e.g. about periods in which changes in administered prices typically enter into force, should be used in order to identify whether or not the infra-annual profile can be considered to be a seasonal profile, in particular with respect to its stability over time.*

## **5.5 Energy**

For the energy subindices the Task Force found that the properties of automatically specified ARIMA models can give a good indication in terms of presence of identifiable seasonality. Models that are specified without seasonal differencing and without any seasonal AR- or MA parameter make a good case for not adjusting an energy subindex for seasonality. Another experiment demonstrated that the effects of price administration can have a distorting impact on seasonally adjusted numbers when, e.g., outlier dummies are used in an unspecified manner, i.e. not taking into account all relevant administrative changes in prices, but accepting the results of automatic outlier identification. Germany presented to the Task Force its results of seasonally adjusting the German energy index from December 2004 on.

Recommendation 10:

*HICP energy price indices should be tested for identifiable seasonality, taking account of administrative measures in form of dummies. If there is evidence that a seasonal profile may have appeared in a part of the time series, the test should be conducted for that part. A seasonal adjustment of energy price indices is only recommended when a sufficiently stable seasonal pattern can be identified and estimated.*

## **6. Summary**

For ESCB purposes, i.e. for analysing and forecasting inflation in the euro area and the EU, HICP series for unprocessed food, processed food, non-energy industrial goods, services and energy are used extensively. Experience gained so far suggests that the seasonal profile can be estimated reliably for these HICP main component series with the exception of energy price indices, given that changes in the prices of fuels, gas and electricity are typically prone to highly volatile and irregular movements or substantially affected by price administration. Another important element in the seasonal adjustment of HICP series is

the inflation analysts' and forecasters' interest in the impact of HICP component series on the respective aggregates. Therefore, it has proven useful to compile seasonally adjusted totals and subtotals by weighting together the directly adjusted component series. The decision on the level of detail at which the direct seasonal adjustment is conducted should not only be based on the statistical properties of the individual time series. A general strategy of the indirect seasonal adjustment of HICPs should also take due account of the importance of breakdowns in the use of seasonally adjusted results and of the side-effects which might be caused by aggregating over different levels of detail.

In 2009 and 2010, an ESCB Task Force looked into the seasonal adjustment of HICPs. The Task Force work unveiled that the seasonal adjustment of HICP series requires the identification of significant one-off effects, e.g. those evoked by changes in excise duties or price shocks. Isolating these effects in the process of seasonal adjustment is usually crucial for the distinction of irregular effects and regular movements. However, the Task Force did not generally opt for a direct seasonal adjustment of those series which are considerably affected by outliers. Rather, it proved useful to analyse case by case the results of seasonally adjusting the main component indices for unprocessed food, processed food, non-energy industrial goods, services and energy either directly or by more detailed breakdowns, thereby giving particular attention to those subindices which are typically affected by changes in excise duties, price administration or calendar effects.

Taking account of user needs the Task Force considered that the direct adjustment of main component series can serve as a useful general framework for seasonal adjustment of HICPs of a certain country and at the euro area level, while arguing that the respective tobacco price indices and calendar effects appearing in price indices for passenger transport by air, package holidays and accommodation services are the most important cases which may deserve a special treatment. With respect to the indirect seasonal adjustment of HICP aggregate series the Task Force took note that the use of normal aggregation weights may impact on the trend level obtained by weighting together seasonally adjusted HICP component series. Adaptations of weights or benchmarking techniques may be used in order to bring trend levels of indirectly adjusted HICP totals or subtotals in line with the trend levels of the respective unadjusted aggregates.

## ANNEX

### LIST OF PARTICIPANTS

Chairperson:

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Secretary:

Mr Martin Eiglsperger ECB

Participants from National Central Banks:

Mr Vladimir Stiller Česká národní banka

Mr Andreas Lorenz (first meeting) Deutsche Bundesbank

Mr Stefan Schipper (second and third meeting)

Mr Sulev Pert (first meeting) Eesti Pank

Mr Konstantinos Lagopoulos (first and third meeting) Bank of Greece

Mr Gianluca Moretti (first and second meeting) Banca d'Italia

Mr Mario Porqueddu (third meeting)

Mr Friedrich Fritzer Oesterreichische Nationalbank

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