15th Meeting of the Ottawa Group on Price Indices

Hosted by the Deutsche Bundesbank
Eltville am Rhein, 10 – 12 May 2017

Report from the meeting

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Introduction

The 15th Meeting of the Ottawa Group on Price Indices was hosted by the Deutsche Bundesbank in Eltville am Rhein from 10 to 12 May 2017. The 2017 meeting was the first to be hosted not by a statistical office but by a central bank. It was attended by more than 100 participants from 30 statistical institutes, 10 central banks, 25 international organisations as well as leading scholars in the field of price statistics.

Further background on the Ottawa Group, including the Terms of Reference and governance arrangements can be found at:

http://www.ottawagroup.org/ottawa/ottawagroup.nsf/home/About%20us

The fifteenth meeting: Summary

The papers submitted for discussion at the meeting were grouped into seven topics and ten sessions. The sessions and session chairs are shown below.

- Session 1: Index theory and practice
  Chairperson: Marcel van Kints
- Session 2: House price indices (HPIs)
  Chairperson: Martin Eiglsperger
- Session 3: Hedonic methods for HPIs
  Chairperson: Christopher Jenkins
- Commemoration Peter von der Lippe
  Chairperson: Jens Mehrhoff
- Session 4: Property price statistics
  Chairperson: David Fenwick
- Session 5: Commercial property prices
  Chairperson: Joachim Recktenwald
- Session 6: Challenges of “big data”
  Chairperson: Carsten Boldsen
- Session 7: Multilateral index methods
  Chairperson: Bert Balk
- Session 8: Issues with new data sources
  Chairperson: Erwin Diewert
- Session 9: Implementing scanner data
  Chairperson: Claude Lamboray

30 papers were presented for discussion in the plenary sessions and 24 papers were presented in a dedicated poster session. A further 2 papers were submitted as room documents. Papers were well received by participants and useful discussions were held on various topics relating to the concepts, methods and compilation procedures for consumer and property price indices. The group debated many issues at the forefront of current thinking on the development and improvement of these indices. The key points emerging from each session are given in the Chairperson's summary notes in Annex A.

Evaluation forms indicated very positive feedback from participants on all aspects and some suggestions for further improvement have been made. The venue, particularly having all in one place at the Conference Centre, was praised. So were the organisation in terms of timing and the meeting itself as regards content. The 15th meeting re-introduced a dedicated poster session for those submissions, which could not be presented for discussion in the plenary due to time constraints given the very high number of excellent submissions. This innovation, first introduced at the 13th meeting, was seen as a welcome development that facilitated discussions in a less formal environment and that should be kept for future meetings. A summary of the participants' feedback is given in Annex B.

The success of the meetings reflected the following contributions:

- the Steering Committee members (OGSC) for their assistance in planning this meeting;
- the session chairs for leading the discussions and preparing summaries of each session;
- the authors for their contributions and the quality of the papers presented;
- all participants for the fruitful discussions and feedback; and
- the staff at the Deutsche Bundesbank for their help in organising the meeting and their support provided to participants.

The next meeting

The next Ottawa Group meeting will be hosted by Fundação Getulio Vargas (FGV) and Instituto Brasileiro de Geografia e Estatística (IBGE) in Rio de Janeiro from 8 to 10 May 2019.

Possible topics for discussion at the next meeting are:

- new data sources to compile price indices (scanner / web-scraped data; quality adjustment);
- compiling property price indices (residential and commercial);
- challenging areas of measurement (e.g. services);
- conceptual frameworks (index number formulae; multi-purpose price statistics); and
- treatment of special cases (strongly seasonal products; zero prices).

The final list of topics will be distributed with the invitation and call for papers.

Jens Mehrhoff
Deutsche Bundesbank
(on behalf of the OGSC)

Annex A: Chairperson's summary notes

Session 1: Index theory and practice
Chairperson: Marcel van Kints

- Christian Blaudow, Florian Burg: *Dynamic pricing as a challenge for consumer price statistics*
- Robert Dippelsman, Erwin Diewert: *Progress on revising the Consumer Price Index Manual*
- Gregory Kurtzon: *Breaking down the differences between the CPI-U and C-CPI-U: weights vs. formula*
- Ludwig von Auer, Jochen Wengenroth: *Consistent aggregation of superlative price indices*

Summary

The opening session on *Index theory and practice* examined a range of topics relevant to both National Statistical Office practitioners as well as important theoretical questions. The theoretical and practical changes of utilising web scraped data to compile the CPI was examined; theoretical examinations of formula and weights of price indexes; as well as the important examination of consistency of aggregation of superlative price indexes. The session also included an update on the development of the revision to the Consumer Price Index manual.

Detailed record of session

The first paper by Blaudow and Burg presented their findings on "Dynamic pricing as a challenge for consumer price statistics".

In this paper the authors examine the evolving data source of online prices and their application to consumer price index compilation. Specifically, *dynamic pricing* is the focus. Dynamic pricing is defined as the application of automatic algorithms in order to change prices in short intervals due to market conditions. Measuring price change is becoming more complex for official price statisticians due to the pace at which these prices change. The question examined is whether the traditional monthly point-in-time pricing approach is sufficient to accurately measure price change for the products in this study.

The study collected hourly prices over three months using web scraping tools. Approximately 2,500 products were priced from 14 online businesses.

The study found that the prices for 1/3 of the sampled products changed more frequently than once per month; suggesting more frequent pricing of these products is ideal when compiling the CPI. The authors also concluded that: (a) the methodology employed in this study would assist CPI compilers to identify businesses who employ dynamic pricing and web scaping is a suitable approach to more frequently price these products; (b) in the majority of cases (i.e. 2/3 of products) traditional price collection each month would accurately capture product price developments; and (c) dynamic pricing is a business strategy likely to evolve and increase in coming years.

The second paper by Diewert and Dipplesman presented on “Progress on revising the Consumer Price Index manual”.

The presentation provided the background and context to the revision to the CPI manual, including the goal to provide more prescriptive advice. The revised manual will also incorporate advances in methods, practices as well as recent research; note developed and developing country contexts; provide practical compilation advice; and serve as a valuable resource for data users.

The presentation noted that there will be one revised CPI manual, with two distinct volumes. Volume I will consider practical topics, and Volume II will be concerned with theoretical topics. The presentation concluded with a detailed description of the timetable to produce the revised CPI manual. Key dates are: (a) country consultation from October 2017 to January 2018; (b) submission of final draft to the Inter-secretariat Working Group on Price Statistics (ISWGPS) in January 2018; and (c) Final Draft submitted to the United Nations Statistical Commission in January 2019.

The third paper by Gregory Kurtzon discussed “Breaking down the differences between the CPI-U and C-CPI-U: weights vs formula”.

The paper examines how much formula and weights matter when attempting to approximate a cost-of-living index. A large economics literature has debated the best formula to estimate a cost-of-living index (COLI). This study shows that formula may not be relevant for many purposes for an index chained at a monthly frequency if current weight information is properly used.

The CPI-U utilises the Lowe formula at the upper levels of aggregation, while the C-CPI-U uses the Tornqvist formula. There are three types of differences in the weights used in the CPI-U versus the C-CPI-U: time span of data, lag, and frequency of updating.

The research by Kurtzon finds the large majority of the difference between the levels of the CPI-U and the generally lower C-CPI- U (a COLI) is due to the CPI-U weights (which constrain quantities to be constant over long periods in the CPI-U but allow implicit quantities to change over long periods in the C-CPI-U), rather than the difference in formula assumptions.

The fourth paper of the session by von Auer and Wengenroth discussed “Consistent aggregation of superlative price indices”.

The authors examine the topic of consistency of aggregation in price indexes. It is considered as a major advantage of a price index formula, when it computes the same overall inflation, regardless of whether it is applied in a single stage or two stage calculation. That is, where on the first stage average changes of subgroups are computed and on the second stage these individual results are aggregated into the overall change. When a price index formula satisfies this postulate, the formula is denoted as consistent in aggregation (or additive).

Consistency in aggregation is important because often CPI users want to decompose the overall inflation into sector specific inflation rates. For example, central banks decompose the overall inflation into core inflation (all products except energy and seasonal food) and the non-core inflation (seasonal food and energy).

The authors examine the topic of consistency of aggregation for superlative price indexes (e.g. Fisher, Tornqvist & Walsh). This is because the current literature lacks consensus of whether these indexes are in fact consistent in aggregation. The paper introduces a formal definition of consistency in aggregation and proves that the three superlative price indices can be considered as consistent in aggregation. Furthermore, many other price indices are shown to be consistent in aggregation. The theoretical findings are applied to the Swedish consumer price index.

Session 2: House price indices (HPIs)
Chairperson: Martin Eiglsperger

- Gregg Patrick: *Ireland's new residential property price index*
- Timm Behrmann, Bernhard Goldhammer: *New developments in the field of house and rental price indices in German price statistics in the light of the hedonic method*
- Erwin Diewert, Ning Huang, Kate Burnett-Issacs: *Alternative approaches for resale housing price indexes*

Gregg Patrick: Ireland's new residential property price index

Gregg Patrick presented how the Central Statistical Office of Ireland's (CSO) created a new set of monthly residential property price indices. Previous indices were based on mortgage-related transaction data from financial lending institutions. Cash buyers were not covered; data on characteristics and micro-location were not available. The new residential property price indices are based on data from several sources which had to be merged and cleaned. From stamp duty data, for example, non-market transactions had to be deleted. Some source data are reported with a delay which necessitates establishing a revision scheme that strikes a balance between data reliability and timeliness of data publication on the other hand and the comprehensiveness on the other hand. Aggregate price data in some market segments tend to be very volatile, due to sparse transactions. The new indices are therefore obtained by exponential smoothing, with different parameter values for the total index and its breakdowns. Differences between the old and the new indices may be related to the coverage of markets outside Dublin. Micro-location data in the new indices allow reflecting price dynamics on a more granular level, compared with the less fine, post-code based segmentation in the old indices.

Timm Behrmann, Bernhard Goldhammer: New developments in the field of house and rental price indices in German price statistics in the light of the hedonic method

Behrmann and Goldhammer elaborated on hedonic regression methods applied for compiling house price indices and price indices on rentals for housing in Germany. While house price indices are designed as hedonic price indices, by imputing the prices which eventually enter the index, hedonic regression is applied to price indices for rentals when a let dwelling in the sample has to be replaced or a dwelling changes in quality.

The Federal Statistical Office of Germany compiles its quarterly house price index with administrative data, i.e. sales prices provided by Expert Committees for Property Valuation. Four regression models in form of hedonic double imputation are run, for new and for existing houses, for new and for existing flats. Imputed prices are aggregated as an unweighted geometric average. The price index

for adjacent periods is a geometric mean of the indices referring to the characteristics of each of the two periods.

Price indices on rentals for housing play an important role for consumer price indices in Germany, because the share of tenants is higher than in most other European countries. When dwellings are replaced or their quality changes, quality adjusted price changes are derived from a hedonic regression. The regression is run with data for Germany; regional and district type dummies as well as dummies for the quality of the residential area allow identifying the impact of location. The paper discusses how unbiased quality adjusted prices are obtained from a log-log regression and illustrates how sitting discounts impact on the value related to changes in quality characteristics.

Erwin Diewert, Ning Huang, Kate Burnett-Issacs: Alternative approaches for resale housing price indexes

Diewert, Huang and Burnett-Issacs use sales prices for the Canadian city of Richmond for comparing different variants of a "builder's model" that decomposes property values into land and structure components. In order to circumvent multicollinearity issues the builder's model is designed as a supply-side model, deriving price changes for the new-structure component from a residential construction cost index published by Statistics Canada. The paper presents eight variants of the builder's model, introducing step by step improvements to the basic approach. A first refinement captures neighbourhood effects by means of 0/1 postal code dummies. Alternative models of depreciation are employed for estimating the value of older structures: geometric structure depreciation, linear depreciation and a piecewise linear depreciation. Property price, structure price and land price indices created from the variants of the builder's model are compared, also with the dynamics of mean and median prices and the corresponding indices obtained by a time product dummy hedonic regression model. Diewert, Huang and Burnett-Issacs conclude that information on property location, the floor space area of the structure, the age of the structure and the lot size is sufficient to generate price indices for Richmond that are reasonably accurate. The inclusion of dummies on the number of bedrooms and bathrooms does not significantly change the movement of the indices.

Session 3: Hedonic methods for HPIs
Chairperson: Christopher Jenkins

- Mick Silver: *How to better measure hedonic residential property price indexes*
- Robert Hill, Michael Scholz, Chihiro Shimizu, Miriam Steurer: *An evaluation of the hedonic methods used by European National Statistical Institutes to compute their official House Price Indices*
- Robert Hill, Alicia Rambaldi, Michael Scholz: *Weekly hedonic house price indices: an imputation approach from a spatio-temporal model*

The session consisted of three presentations discussing the use of hedonic methods for the production of House Price Indices (HPIs). The first presentation discussed the development of a practical hedonic methodology that consolidates and builds on limitations with existing hedonic models. The discussion identified that the proposed methodology was suitable for use in production

and would benefit from being tested using a country dataset. Any volunteers were requested to contact the author. The second presentation provided an overview of the main hedonic methods used by national statistical institutes (NSI) in the European Union to compute HPIs. The methods were evaluated using detailed micro-level data sets for Sydney and Tokyo, with the findings indicating that the results are generally quite robust to the choice of hedonic method. Whilst the presentation recommended that those NSIs using a re-pricing approach should consider switching to another hedonic method, the discussion that followed identified where re-pricing is used, countries appear to be updating the reference shadow prices annually. There was a request from the presenter for those countries who use a re-pricing approach to confirm the frequency at which they update shadow prices. The third and final presentation of the session looked at the development of a new method for computing hedonic imputed house price indices at a weekly frequency building on previous work in this area. It was suggested that such high frequency indices would provide Central Banks with a richer source of data to assess housing markets. The presentation concluded that applying the proposed model produces results that outperform other approaches for high frequency HPIs.

Commemoration Peter von der Lippe
Chairperson: Jens Mehrhoff

- Bert Balk: *Mixed-form indices: a study of their properties*

The paper Mixed-form indices: a study of their properties presented in this special session dedicated to commemorate the contributions of Peter von der Lippe to index theory and price statistics, reviewed the properties of mixed-form indices. In the short term, the indices are formed using direct formulae, e.g. the one of Laspeyres. A long-term time series is formed via chain-linking. An example is the European Harmonised Index of Consumer Prices (HICP), where the chain-linking is performed annually, with December being the linking month. Peter von der Lippe was one of the most prominent opponents of chaining. The paper shows that there are indeed several complications in chain-linked time series, such as the loss of consistency in aggregation as well as the lack of interpretability of annual rates of change.

Nonetheless, the paper gives important insights into the underlying structure of mixed-form indices. Most notably, the annual rate of change is the product of two indices and, hence, difficult to interpret. As a consequence, the product does not satisfy the proportionality test, i.e. even if all prices change at the same rate, the annual change does not necessarily equal the constant rate of change. In the same manner, contributions to growth, i.e. how much of the current inflation rate stems from which component of the basket of goods and services, cannot be calculated straightforwardly either. The author provides an alternative decomposition using logarithmic means.

He concludes that the traditional distinction runs between direct and chained indices. However, mixed-form indices materialise usually where monthly indices must be compiled (but the chain-linking is performed annually, only). The interpretation of these indices and derived measures, such as rates of change, require some care.

Session 4: Property price statistics
Chairperson: David Fenwick

- Robert Szemere: *BIS consumer and property price statistics: cross-country comparability and historical perspective*
- Andrew Kanutin: *Real estate statistics – building from the micro level*

The presentation entitled "BIS consumer and property price statistics: cross country comparability and historical perspective" (Robert Szemere) covered both consumer and property price statistics and summarised the characteristics of the price statistics data sets of the BIS, with particular attention to the current state of play in terms of coverage. The recent expansion of the country coverage of the BIS residential property price statistics and the launch of the collection and publication of commercial property price indicators were triggered by the Data Gaps Initiative of the G20 economies.

The presentation entitled "Real estate statistics – building from the macro level" (Andrew Kanutin) focused on the publication by the European System of Central Banks (ESCB) of experimental indicators on Residential and Commercial property prices and work in progress on a new data source which allows, for the first time, an examination of data at a much more granular level. This is against a background of a requirement for Supervisory Authorities to assess both residential and commercial real estate in regular reports and of an increasing requirement for granular data. The presentation noted that there was no mandate for data collection.

Both papers generated lively discussion both with respect to determining the reliability of data sets and to definitional and coverage issues. It was noted that harmonisation of concepts and methodologies was a pressing issue and that a lack of authority to collect data was a barrier to progress. Concern was also expressed about reliance on commercial databases and issues arising relating to relevance, reliability and resilience. Particular concern was expressed about the use of valuations data for commercial property. National Statistics Institutes should be encouraged to collect transactions data and publish "official" indices. It was noted that the forthcoming publication by Eurostat of a Working Document on the compilation of commercial property price indices should facilitate the production of official statistics with a view to reaching a consensus on best methodology which can be the basis for harmonisation.

Session 5: Commercial property prices
Chairperson: Joachim Recktenwald

- Erwin Diewert, Chihiro Shimizu: *Commercial property price indexes for Tokyo revisited*
- Inês Gonçalves Raposo, Rui Evangelista: *A transactions-based commercial property price index for Portugal*
- Barra Casey: *Developing a new commercial property statistical system (CPSS) for Ireland*

The System of National Accounts requires separate estimates for the land (non-produced asset) and the structure (produced asset) components of non-financial assets. Against this background, the authors of the first presentation used transactions data for office buildings in Tokyo to estimate the Builder's Model which generates both a quarterly overall property price index and sub-indexes for

land and structures. The results can be considered encouraging when compared with official annual appraisal values for land. When the Builder's Model is estimated using appraisal and assessment values instead, it turns out that the corresponding indexes lag behind those based on transaction prices. An important task for the future is to extend the coverage of the indexes to include other types of commercial properties. A next challenge would then be to seek full country coverage.

The second presentation reported on a joint Banco de Portugal/INE project: the compilation of a transactions-based commercial property price index for Portugal. The index is based on administrative data: as for the house price index, a source on transactions can be linked to another source which provides the characteristics of the commercial properties. Using the adjacent time dummy approach indexes are estimated for three strata of commercial properties: retail, services and industrial. Residential commercial property is excluded. The land component of commercial properties is included. The administrative sources used allow also for the compilation of statistics on the value and the number of commercial property transactions. In the second half of 2017, INE plans to start the regular publication of the CPPI data.

The third presentation reported on a project launched by the Irish Central Statistics Office (CSO) with the aim of ascertaining whether it was possible to develop a Commercial Property Statistics System. That System should cover the overall stock, the stock under construction (called pipeline) and the transactions (sales and leases) of commercial property. In each of the three strands of the project, the key element was to explore the possibility of matching data from different administrative sources. It was found that there is a potential to build a pipeline database of commercial property and – although data matching would be very resource intensive – a stock database. However, a multitude of problems were found in the matching of transactions data. Therefore, new data sources will be required to add important characteristic variables to the transactions information.

In the discussion, banks were mentioned as a possible data source given the banks' role in financing properties. Reference was also made to possible source data-related difficulties in cases cases where a company is set up with the only purpose to own a commercial property. A change of ownership of the property (via the sale of the company) would then not show up as a transaction of a non-financial asset. Such cases might lead to coverage gaps and a risk of bias.

Session 6: Challenges of "big data"
Chairperson: Carsten Boldsen

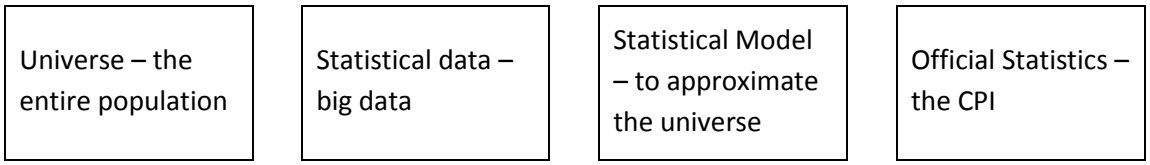
- Marcel van Kints: *Enhancing the Australian CPI: making greater use of transactions data to compile the Australian CPI*
- Alan Bentley, Frances Krsinich: *Towards a big data CPI for New Zealand*
- Josef Auer: *From price collection to price data analytics – How new large data sources require price statisticians to re-think their index compilation procedures. Experiences from web-scraped and scanner data.*
- Jens Mehrhoff: *A "big data" gaze at why electronic transactions and web-scraped data are no panacea*

The paper Enhancing the Australian CPI: making greater use of transactions data to compile the Australian CPI gives an overview of the work of the ABS in investigating the possibilities for using scanner data for the compilation of the Australian CPI. Scanner data, potentially, can replace survey data for about 25% of the CPI weighting base and lead to better quality price indices and reduce labour intensive work. To avoid problems with drift associated with bilateral indices ABS considers implementing multilateral indices for scanner data and has tested different models focusing on the GEKS-Törnqvist and the weighted time product dummy method using the ABS Data Quality Framework. The tested multilateral methods give very similar results with no systematic differences and both are less volatile than the current CPI. When extended a period multilateral methods involve a revision of previous period's price indices, which is a drawback for the regular CPI, which is usually not revised. To avoid revision of previous indices different methods can be applied. The paper applies two extension methods (Rolling window approach and direct annual extension). The resulting indices are more sensitive to the extension method than to the multilateral index method. A "mean splice" extension method is the preferred one. The paper also discusses the classification structure and at what level to fix weights and different lengths of the estimation window. ABS is likely to recommend the GEKS-Törnqvist as preferred multilateral model and to be applied at respondent classes and aggregating these into expenditure classes using Törnqvist formula and using an estimation mean splice window of 9 quarters (25 months).

Towards a big data CPI for New Zealand explore the path to a "big data" CPI for New Zealand. The paper argues there is a regime shift from the traditional production set-up for the CPI based on targeted sample surveys, to a CPI based on an abundance of (high-frequent and timely) data for different subsets of the population. The drivers for the change towards a big data CPI includes competition from other providers of alternative measures of price changes, the possibility of producing more timely and more frequent CPIs, more efficient production and reduction of costs. The paper reflects on the experiences of Statistics New Zealand on model-based approaches for estimation of quality-adjusted price indexes. Rather than using big data to "plug into" the fixed-basket index, the strategy is to find the optimal route to measuring pure price change, while controlling for the changing composition of the products being sold. The coverage for goods is reported to be quite good; 24 out of 43 COICOP group categories can be covered by big data or scanner data. However, services are poorly covered by big data and it may be necessary to exploit other sources to ensure sufficient coverage of services. The Fixed Effects with a Window Splice (FEWS) index uses the longitudinal information to implicitly quality-adjust the price indexes. In production, this can be combined with a modified approach to splicing that incorporates the price movement across the full estimation window to reflect new products with one period's lag without requiring revision. Statistics New Zealand plans further research based on daily web-scraped data purchased from a commercial data provider. Using online data in combination with expenditure information from surveys or scanner data presents a rich opportunity for more frequent and timely price indicators than are currently available.

The paper From price collection to price data analytics – How new large data sources require price statisticians to re-think their index compilation procedures. Experiences from web-scraped and scanner data gives an overview of the challenges associated with moving from a traditional survey based approach to a big data approach including scanner data and web-scraped data. The Austrian paper, as the paper from New Zealand, refers to a paradigm shift when moving to a big data CPI. While big data has the potential to improve official price statistics in terms of quality and efficiency,

there are also a number of methodological and operational issues that statistical offices need to consider. The production of the CPI is discussed in terms of a model of the production of the CPI consisting of four elements/steps:



A number of issues related to web-scraped data are discussed. For instances, are web-scraped prices also the prices actually paid by households, and there is a lack of quantities, which need to be collected or estimated from other sources. There are also risks associated with web-scraping (importing viruses or malware), for which reason Statistics Austria has decided to execute web-scraping from a stand-alone system. The paper discusses quality problems and measurement for both transactions (scanner) data and web-scraped data, according to a number of quality dimensions: relevance, accuracy, timeliness/punctuality, accessibility, completeness and clarity/interpretability. The paper concludes that there is a need for an analytical approach to quality control and developing automated processes and that that new skills ("data science") are needed in order to develop processes that comply with the quality standards of official statistics.

The paper A "big data" gaze at why electronic transactions and web-scraped data are no panacea raises a number of issues to take into account when exploring big data.

Electronic transactions cover only a sub-set of all transactions in the population. Some transactions are not recorded electronically, and of the electronic transactions not all are available to the statistical office. Of these available, some are deleted by cleaning or omitted because no match is found. The large size of big data compared to a much smaller simple random sample does not necessarily means better quality of an index based on big data. What makes big data big is not its absolute size, but its relative size, and what matters, at the end, is the quality of the data. The most representative price of a product sold over a month at different prices is the unit value. On this basis, the paper compares the likely statistical errors of web-scraped data and transactions (scanner) data. It is concluded that web-scraped data and scanner data may have limited accuracy and that combining big data with survey data may be the way forward.

In summary, based on the presentations and the following discussions, it was concluded that moving to a big data based CPI involves major issues concerning data quality, methodology and the CPI production process, including also conceptual issues – e.g. what is the target CPI when going from bilateral indices based on targeted samples to (multilateral) indices based on big data? While big data facilitate production of more detailed CPIs, NSOs would need to take confidentiality into account. It was also mentioned that the consumption of the very rich may still be under estimated. Big data and scanner data is still in the developing phase, where a handful of countries have implemented mainly scanner data for their regular CPI. To move forward, it will be useful for countries to share experiences and good practices.

Session 7: Multilateral index methods
Chairperson: Bert Balk

- Antonio Chessa, Jan de Haan, Johan Verburg, Leon Willenborg: *A comparison of price index methods for scanner data*
- Erwin Diewert, Kevin Fox: *Substitution bias in multilateral methods for CPI construction using scanner data*
- Claude Lamboray: *The Geary Khamis index and the Lehr index: how much do they differ?*
- Jan de Haan, Rens Hendriks, Michael Scholz: *A comparison of weighted time-product dummy and time dummy hedonic indexes*

Simultaneous with the increasing use of electronic transaction data (*aka* scanner data) in official consumer price statistics goes an increasing interest in adapting multilateral index number methods, known from the field of international price comparisons, to the time series context. The basic idea behind this approach appears to go back to a 1981 *Statistische Hefte* paper by Bert M. Balk. The main issues are: 1) which method to choose given a certain purpose, and 2) how to cope with the progress of time which leads to a continuous expansion of the data sets involved.

The first paper, "A comparison of price index methods for scanner data", by Antonio G. Chessa, Johan Verburg and Leon Willenborg, compared the direct Jevons, direct Törnqvist, GEKS-Törnqvist, Geary-Khamis, Weighted Time Product Dummy, and Weighted Time Dummy Hedonic methods on monthly aggregated scanner data from a department store.

The second paper, "Substitution bias in multilateral methods for CPI construction using scanner data", by W. Erwin Diewert and Kevin J. Fox, compared the chained Fisher, chained Törnqvist, GEKS-Fisher, GEKS-Törnqvist (*aka* CCDI), Weighted Time Product Dummy, and Geary-Khamis methods on artificial data sets generated by a CES unit cost function and adjusted for product sales.

The third paper, "The Geary Khamis index and the Lehr index: How much do they differ?", by Claude Lamboray, compared the Geary-Khamis index to a multilateralized Lehr index as well as a chained Jevons index. Its empirical application is on monthly aggregated scanner data from a retail chain.

The fourth paper, "A comparison of weighted time-product dummy and time dummy hedonic indexes", by Jan de Haan, Rens Hendriks and Michael Scholz, analyses the difference between the two methods and applies them to monthly aggregated scanner data from a retail chain.

All the papers also played around with various computation-window updating methods.

Though all these papers contain concluding sections which express a preference for this or that method, it was felt too early to draw some overall conclusion.

Session 8: Issues with new data sources
Chairperson: Erwin Diewert

- Jörgen Dalén: *Unit values in scanner data – some operational issues*
- Elizabeth Metcalfe, Tanya Flower, Thomas Lewis, Matthew Mayhew, Edward Rowland: *Research indices using web scraped data: clustering large datasets into prices indices (CLIP)*
- Kota Watanabe, Tsutomu Watanabe: *Price rigidity at near-zero inflation rates: evidence from Japan*

Summary of the Session

The paper by Jörgen Dalén is a very useful one for consumer price statisticians. This paper lays out a framework for utilizing scanner data in the construction of a CPI.

The second paper by Elizabeth Metcalfe, Tanya Flower, Thomas Lewis, Matthew Mayhew and Edward Rowland is also a useful one in that it addresses the problems that arise when web scraped data is used in order to construct elementary indexes in the first stage of the construction of a CPI.

The final paper by Kota Watanabe and Tsutomu Watanabe looks at the contribution of price rigidity during the period of price deflation for the Japanese CPI.

Detailed record of the session

Paper 1

The first paper by Jörgen Dalén, "Unit Values and Aggregation in Scanner Data – Towards a Best Practice", was an important one which presented a framework for aggregating scanner data at the first stage of aggregation.

Scanner data collects data from retailers on quantities sold and value of sales by detailed product and by retail outlet. Values and quantities are distinguished by:

- a product bar code;
- single outlet or a chain of outlets;
- hourly, daily, weekly, monthly or quarterly data on quantities sold and sales revenues by bar code and retail outlet;
- additional information on the characteristics of the products sold.

Dalén explained that when constructing a typical national CPI or when constructing the Eurostat HICP (Harmonized Index of Consumer Prices), there are usually *three stages of aggregation* going from price and quantity (or value) data on consumer purchases of individual products to the final overall Consumer Price Index:

- The construction of *appropriate unit value prices* for individual products.
- The aggregation of *homogeneous products* into a narrowly defined commodity class. Dalén's paper is directed towards improving the construction of the HICP and so he regarded these narrowly defined commodity classes to be the lowest level of aggregation for an index which has with fixed expenditure weights at this intermediate level of aggregation. He referred to an elementary index at this intermediate level of aggregation as a *consumption segment*.

- The third level of aggregation is the aggregation of consumption segments into higher level product groups and eventually into the All Products CPI.

Dalén noted that the third level of aggregation is not affected by the existence of scanner data and so this level of aggregation was not discussed further in his paper. While this observation may be true when constructing the EU's Harmonized Index of Consumer Prices, it is not necessarily true when constructing national Consumer Price Indexes (see for example the proposals by the Australian Bureau of Statistics (2016) for the use of scanner data in constructing the Australian CPI).

Dalén followed the *Consumer Price Index Manual* (2004) and takes as a general principle that transactions (sales or purchases) at the lowest level of aggregation should be aggregated using *unit value prices for homogeneous products*. This general principle suggests that unit value prices should be constructed for each individual product (with its own unique barcode) at each location in the country where the product is sold. Dalén then went on to discuss several problems that arise if we attempt to implement this recommendation.

The *first problem* is the *choice of a time period* for the unit value. If the time period is chosen to be a short one, then there will generally be a *problem with zero sales and prices* for individual products for these short time periods, leading to a lack of matching of prices across time periods. However, the usual frequency for CPI is a month and so it would seem that the time period should be chosen to be one month. But the transaction data on individual products often comes on a weekly basis so there are some problems in converting these weekly data into monthly unit values. There can also be problems with time of day pricing; i.e., bars often have regular "happy hours" where alcoholic beverages are sold at discounted prices; movie theaters sometimes offer discounted prices on certain days of the week and so on. If these time of day or time of week prices have the same general movements over time as "regular" prices, then forming a single unit value price over regular and discounted prices will not cause problems for the overall index construction but if this is not the case, then separate unit value prices should be constructed for regular and discounted prices.

The *second problem* is whether to form unit values for a single product over a chain of retail outlets or form individual unit values for each separate outlet in the chain. To resolve this problem, Dalén suggested that we follow the advice of Ivancic and Fox (2013):

"The same item sold by different sellers is viewed as homogenous if the price of the item is found to be consistently the same across sellers in the long term."

Thus if the chain enforces uniform pricing across its outlets, then unit values for the same product over all stores can be formed but if individual outlets are allowed to have different prices for the same product, then separate outlet unit values should be constructed. Dalén explicitly mentioned that separate unit value prices for online sales by a chain or single outlet should be constructed since it is quite possible that price movements for the online segment of sales could be quite different from the movements for in store sales. However, over time, the statistical agency could determine whether these prices move in a proportional manner over time, in which case each product could be aggregated into a single "homogeneous" category that included both types of sales. A recent paper by Cavallo (2017) compared online and offline prices for large retailer chains that have outlets at multiple locations and he found that within-retailer price dispersion is actually quite low and that most of the price dispersion in prices for the same product occurs across store chains.

A *third problem* addressed by Dalén is the difficulty statistical agencies will have in handling *hundreds of thousands of bar codes* and the associated flows of data. He did not offer any specific advice on how to deal with this problem but presumably, methods for dealing with "big data" will emerge over time, including sampling methods. Dalén also mentioned that the scanner data that is collected by a statistical agency will not be comprehensive.

The *fourth problem* discussed by Dalén is the *relaunch problem*. This problem was noted many years ago by Reinsdorf (1999) and de Haan (2002) and it arises when a product with a specific bar code disappears but more or less the same product reappears at a later date with a new bar code. Dalén noted the research by Chessa (2013) that indicated that frequently, the relaunch price is significantly higher than the price of the predecessor product and so the relaunch process can frequently be viewed as a method for disguising product price increases. If the relaunched product is treated as a new product, then using existing statistical agency practices, the increase in price will not be registered in the elementary index. Dalén's solution to this problem (following the approach of Chessa) is to group products with very similar characteristics into a unit value aggregate, since products with very similar or identical characteristics will generally give consumers the same utility and hence the aggregate quantity of these similar products is a reasonable quantity measure for the group of products and the corresponding group unit value price is an appropriate aggregate price for the group of products. Dalén called such a group of homogeneous (or highly homogeneous) products a *consumption segment*. This recommendation is a very reasonable one but there are some difficulties associated with this advice:

- In order to form the group unit value, accurate and comprehensive information on *product characteristics* is required and this information may not be available.
- Since there are *hundreds of thousands of products* in a CPI universe of products and each product will generally have multiple important utility determining characteristics, the process of grouping products into homogeneous product groups may require significant resources and these resources will generally not be available to the statistical agency. For product segments that have a large number of individual products, Dalén suggested that a *sampling approach* may have to be utilized. He also suggested that, initially, products in a product category could be grouped according to their *price levels*. This is sensible advice but one needs to be aware that at the time of the initial grouping of products, some of them might be on sale. Thus as mentioned by Dalén, grouping similar products according to their price levels should be done over a period of time that is long enough to diminish the effects of sales.
- Although many product relaunches may be simple price increases in disguise, some product relaunches may have additional utility and this means that some *direct quality adjustment* is called for. Across the world, research and development expenditures are probably higher than ever. Some of these expenditures lead to new products (which must show up somewhere in the existing product classifications) and surely some of these products give a higher level of utility than existing "old" products and hence some direct quality adjustment is called for. But it is difficult to do this quality adjustment in a *reproducible and objective* manner. However, we note that de Haan and Krsinich (2014) have developed a method for quality adjustment which is objective and reproducible provided suitable information on product characteristics is available.

Dalén mentioned a *fifth problem* that is associated with forming a homogeneous product group (or consumption segment). This problem is related to the product relaunch problem and is caused by *very short product life cycles*. Thus "new" products are constantly appearing in the marketplace and "old" products are disappearing. Thus, some form of direct quality adjustment is necessary for new products that have enhanced characteristics. If the new products do not have enhanced capabilities, then Dalén's grouping strategy can be used (but in this case, the "new" product is not really new).

Finally, Dalén mentioned briefly a *sixth problem* associated with forming unit value aggregates for a product and this is the problem of *zero sales* of the product for some time periods but not other time periods. Obviously in many cases, grouping similar products into a consumption segment will solve this problem so that for the entire product segment, a positive aggregate quantity and a positive unit value price will be obtained and the next stage of aggregation can proceed using an agreed upon index number formula. But for some consumption segments, positive aggregate prices and quantities for the product group will not be obtained for all time periods within a year; i.e., *strongly seasonal commodities* will be available at some periods within the year but not at out-of- season time periods. Thus grouping similar products into a near homogeneous unit value will not necessarily generate positive prices and quantities for a strongly seasonal consumption segment for all months in a year. Dalén suggested that the problem of zero prices could be solved by using a dynamic approach to index number theory.

In pages 9-12 of his paper, Dalén introduced his *dynamic approach* to the treatment of scanner data where he addressed some of the problems associated with forming elementary indexes over time. On page 9, he contrasted the dynamic approach with the usual *static approach* as follows:

"With the dynamic approach it is possible to assign algorithms that are well-defined functions of, in principle, all transactions. On the contrary, the static approach necessarily involves replacements and imputations that are more or less impossible to define rigorously and therefore give room for subjectivity and arbitrariness. The static approach does not move us away from the non-transparent and non-comparable procedures that plague today's practices."

Dalén went on to describe in more specific terms what his dynamic approach entails. It seems that the dynamic approach has two main characteristics:

- It uses the price and quantity data in a product category over multiple periods and thus is a *multilateral index number method*.
- The multilateral method must be free of *chain drift* within a window of time periods. Three examples of multilateral methods that Dalén endorsed (and are free of chain drift) are the modified Geary-Khamis (GK) method proposed by Chessa (2016), the Weighted Time Product Dummy (WTPD) method developed by Prasada Rao (1995) (2005), Diewert (2004), Ivancic, Diewert and Fox (2009) and de Haan (2015) and Rolling Year GEKS developed by Ivancic, Diewert and Fox (2011).

Dalén noted that if chained Laspeyres indexes are used at the elementary level, a very large upward bias usually occurs, if chained Paasche indexes are used, then a very large downward bias usually occurs and if a chained superlative index (like the Fisher or Törnqvist) is used, then a small but significant downward bias usually occurs. The use of a multilateral index number method like those mentioned above generally reduces chain drift bias. However, it should be noted that the GK and

WTPD methods can be subject to a certain amount of substitution bias as noted by Diewert and Fox (2017) in another paper presented at this meeting.

On page 11 of his paper, Dalén noted that the chain drift problem (within a year) can be avoided if a direct bilateral index is used which compares the prices (and quantities) for a sequence of 12 consecutive months with the prices (and quantities) of a base month such as December (which is what is done in constructing the EU's Harmonized Index of Consumer Prices). However, he also noted two problems with this *straightforward fixed base within the year* methodological approach:

- The problem of vanishing products and the appearance of new products means that many prices of new products cannot be compared to the prices of the same products in the base month (because these prices did not exist). Similarly, short product cycles and the existence of strongly seasonal commodities mean that for many products, prices for products available in the base month are not available in subsequent months.
- The index number procedure is not symmetric with respect to the choice of the base month. If a different base month were to be chosen, different indexes would result in general. This is not an attractive property.

Multilateral methods avoid the above two problems associated with the fixed base within the year approach.

Returning to the dynamic or multilateral index number approaches, all three of the recommended multilateral methods (GK, WTPD and RYGEKS) are subject to *new products bias*; i.e., these methods do not properly account for the possible utility benefits of new products and the possible utility losses from the disappearance of existing products. To see this, consider a two period example with only two products. Product 1 is present in both periods. Product 2 is a wonderful new product that is not present in period 1 but is present in period 2. When one works out the price index for this example using the GK, WTPD and RYGEKS methods, we find that the group price index is equal to the single price ratio of the price of product 1 in period 2 divided by the price of product 1 in period 1; i.e., the introduction of the new product has no effect at all on the group price index.

In order to deal with the introduction of new products in an economic framework, there are at least three possibilities:

- Use hedonic regression methods if information on product characteristics are available (see de Haan and Krsinich (2014) for examples of this technique);
- Use econometric techniques and estimate reservation prices for a new product in the period before its introduction (this methodological approach is due to Hicks (1940) and an example of the approach may be found in Hausman (1997)) or
- Use the Constant Elasticity of Substitution index number method developed by Feenstra (1994) that accounts for new and disappearing products.

All three methods have their difficulties. The first method cannot deal adequately with new products that are not similar to existing products; the second method is difficult to implement and the third method assumes that the reservation prices for new products are infinite and thus may overstate the benefits of an expanding product choice set.

At the end of his paper, Dalén made three main recommendations:

- Definitions of homogeneity should be such that relaunches are neutralized, both identical and similar relaunches. Avoiding unit value bias is a second priority by comparison but should nevertheless be addressed to the greatest extent possible.
- Dynamic methods, which cover the evolving universe of transactions as close as possible are superior to static methods, which try to assign low level reference units from a historic period. (When choosing the best dynamic method, listen to research, which is still evolving!)
- Ensure that methods are guaranteed free of intra-year chain drift.

We conclude that his paper provides a useful framework for organizing scanner data into elementary indexes but there are still a number of significant research questions that need to be addressed before we can determine what is the best practice in forming elementary indexes for a Consumer Price Index when scanner data are available.

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Paper 2

The second paper "Research Indices Using Web Scraped Data: Clustering Large Datasets into Price Indices (CLIP)" was presented Matthew Mayhew from the Office for National Statistics in the UK.

This is a very interesting paper that deals with a topic of fundamental importance to statistical agencies charged with the task of producing a Consumer Price Index: namely, how to aggregate item prices in narrowly defined product category into an elementary price index. The authors use posted online prices for 33 CIPH elementary classes of consumer products taken from 3 major UK retail chains using daily web-scraping price collection techniques in order to construct new experimental elementary indexes for these 33 elementary categories. The authors point out that they have collected approximately 8,000 *daily* online product prices since June 2014 from these three retailers. They note that the traditional price collection methods used in the UK CPI collect only 6,800 prices per *month*. Thus collecting prices online potentially could lead to greatly improved elementary indexes for the UK due to the vastly increased number of price quotations that result from web scraping. The information that is collected is:

- a product description;
- the offered selling price of the product;
- the store location and
- the discount type.

The authors note that there are some limitations with their analysis; i.e., only the prices of 3 large retail chains are used and so the coverage is incomplete and, most importantly, there are no quantities sold to go along with the posted prices. Thus best selling items will necessarily get the same weight in the resulting indexes as items which sell infrequently. But of course, this is a limitation which also applies to traditional price collection methods.

The paper clearly illustrates a major problem with using web scraped data and that is the problem of *product churn*; i.e., many products disappear each day to be replaced by "new" products. The authors also note that sometimes products disappear for short periods of time only to reappear later, perhaps due to temporary stock shortages. The authors note a more serious problem and that

is the *rebranding phenomenon*; i.e., a "new" product appears with a new scanner code but it is in fact more or less identical to the previous "old" product that it replaces.

To overcome the product churn problem, the authors propose to group similar products into a group or cluster and then form the geometric mean of the prices of the products in the cluster over each month. These monthly geometric mean prices can then be compared to the base month geometric mean price for the cluster of products in order to form an elementary index.

But how exactly are the products grouped into a cluster of products? The authors offer the following description of their clustering method on page 7 of their paper:

"In the base time period, the data within each item level classification are used to form similar clusters. Nonunique products within the base period are aggregated using a geometric mean prior to calculating the CLIP, which stops products that are collected regularly being over represented when calculating the clusters. An unsupervised machine learning approach is taken to cluster together similar groups of products. The clustering technique used is not pre-defined and should be chosen to form optimal clusters. ... In this case, we have decided to use the method of mean shift clustering. ... Mean shift clustering uses kernel density estimation to estimate the underlying distribution of the dataset. It then places a kernel (weighted function) on each data point and then iteratively shifts each point until they are at the maximum of their nearest kernel density estimation surface."

It is not clear how the clustering algorithm works in practice. Products should be grouped into clusters based on the similarity of their characteristics. But the list of characteristics that were available to the authors is rather meager. The four characteristics that were used were the product description, the offered selling price of the product, the store location and whether the price was a discounted price. Typically the product description will not include many characteristics of the product; e.g., a particular brand of tea may just be described by the word "tea" and the package size. One might think that the price of an item might be used as a grouping factor so that products with relatively high prices would be regarded as "premium" products. But the authors on page 8 of their paper (quite rightly) rule out using price as a grouping factor:

"The features that are used to create the decision tree are the product name, shop and discount marker. Price has not been used to allocate products to clusters."

It can be seen that it is not at all clear how products were grouped into clusters. If detailed product characteristics are available, then it would seem that a hedonic regression procedure would be more appropriate than simply grouping products into cells. If detailed product characteristics are not available, then it is likely that the clustering procedure suggested by the authors will not be reproducible; i.e., different statistical agencies will implement the suggested clustering algorithm in different ways.

Paper 3

The third paper "Price Rigidity at Near-Zero Inflation Rates: Evidence from Japan" was presented by Tsutomu Watanabe.

The paper looks at the characteristics of Japan's experience with price deflation since 1995. In particular, the paper noted that most of the items in the Japanese CPI experienced no change in price, indicating the wide spread prevalence of price stickiness.

The paper will be of most interest to macro economists who are interested in the phenomenon of deflation.

Session 9: Implementing scanner data
Chairperson: Claude Lamboray

- Li-Chun Zhang, Ingvild Johansen, Ragnhild Nygaard: *Testing unit value data price indices*
- Guillaume Rateau: *Implementation of the treatment of the scanner data in France*
- Kristiina Nieminen: *New data sources to compile price indices: small scale "big data" for the index compilation*

The session on implementing scanner data included presentations prepared by Statistics Norway, INSEE from France and Statistics Finland. When introducing new data sources in statistical processes, statistical agencies must take many decisions driven by both practical and theoretical considerations.

The first presentation made by Norway focused on price indices based on unit values. This approach acknowledges the fact that the set of available items can be different in each period. That is why new tests for evaluating the different price index formulas are required. It was also assessed empirically how the indices are impacted by segmentation methods that automatically group the items. During the discussion, it was clarified how the different tests can be motivated from both a COLI and a COGI perspective. This presentation highlighted the need to better understand and to further develop the methods in the context of a dynamic item universe.

In the second presentation, the methodological approach chosen by France for implementing scanner data was explained. In particular, the different options for aggregating over time were extensively analyzed as a monthly CPI must be derived from daily scanner data. Explanations were also provided on the impact of discounts and relaunches as well as on the use of filters that remove extreme price changes.

In the third presentation, Finland showed how scanner data for pharmaceutical products had been introduced in CPI compilation. Additional simulations were conducted on this scanner data set. Fixed base and chained versions of superlative price indices were tried out in order to further improve the accuracy of the sub-indices.

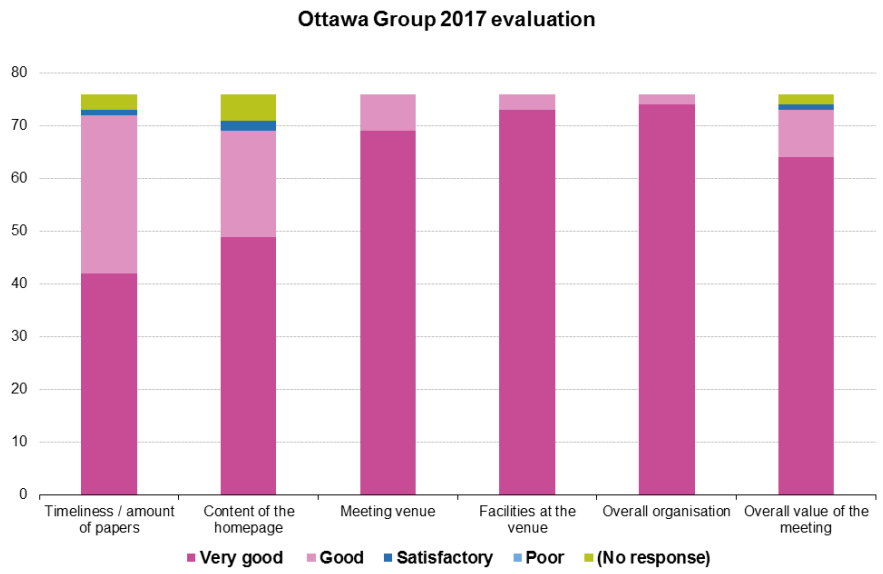
Annex B: Summary of the participants' feedback

In what follows a summary of the participants' feedback along with an evaluation of the results is presented. In total, 76 questionnaires were received after the meeting. A graphical analysis is presented at the end.

The general questions about the meeting quality showed that the 15th meeting of the Ottawa Group was perceived a great success with constructive discussions and debates on many of the key issues faced by compilers of price indices today. Timeliness of papers continues being an issue raised by some participants, very much like at previous meetings already. To some extent, though, this is beyond the control of the organisers (several reminders where sent closer to the meeting date). Downloading every paper and presentation separately was found cumbersome. An additional zip file containing all presentations and papers is something that would be doable for future meetings.

It has been suggested that the poster session should have been split into two. Indeed were 24 posters an exceptionally large number. Also, authors should be encouraged to prepare hand-outs. In terms of topics, there was a wish for more diversity; in particular it was questioned whether property prices should be so prominent – this is underlined by the feedback on which sessions have been found most useful (see below). The Ottawa Group focusses on taking forward state-of-the-art ideas, which encompasses for example the advent of scanner data and their treatment with multilateral methods, rather than more applied topics that are covered every other year in the Meeting of the Group of Experts on Consumer Price Indices at the UNECE in Geneva. As regards property prices, most participants of the Ottawa Group meetings will have a background in consumer prices and, hence, there might be a mismatch to some extent. Since property prices are a significant measurement issue, there needs to be an effective forum to take the subject forward. The Ottawa Group Steering Committee, with the support of the Inter-secretariat Working Group on Price Statistics, will discuss this question and next steps further.

Last, the results of the questionnaire confirm the value of the poster session and that it should be kept for future meetings. In the same vein, sufficient time for discussion should be ensured at subsequent meetings, too.


Ottawa Group 2017 evaluation
80
70
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20
10
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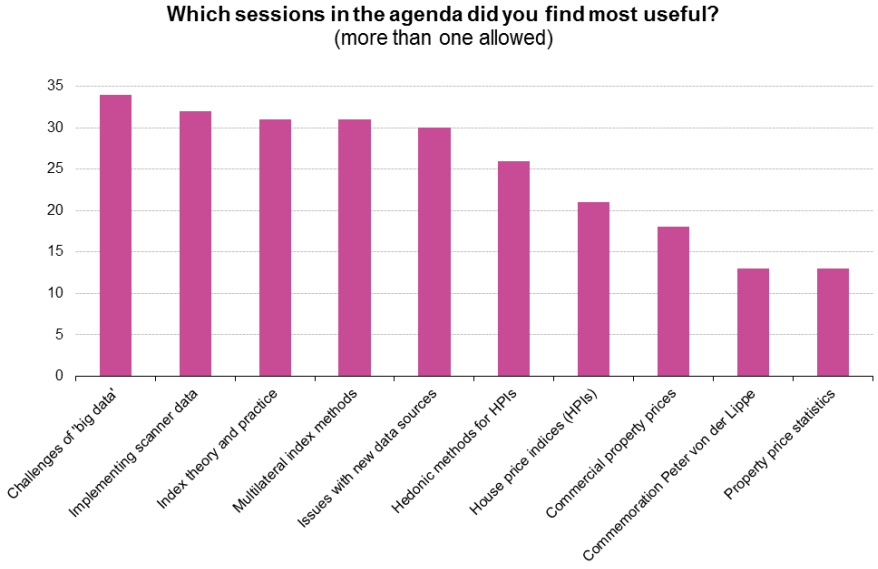
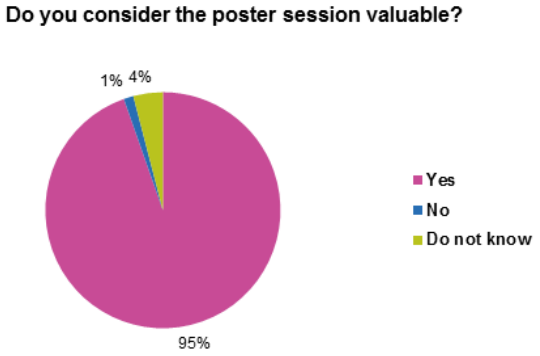
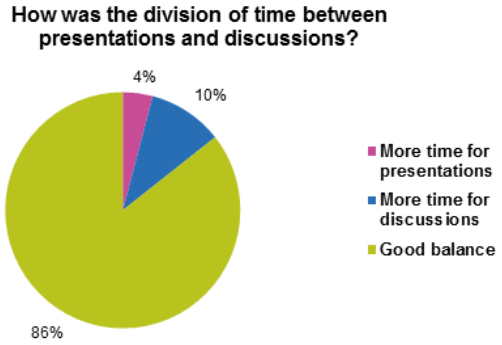
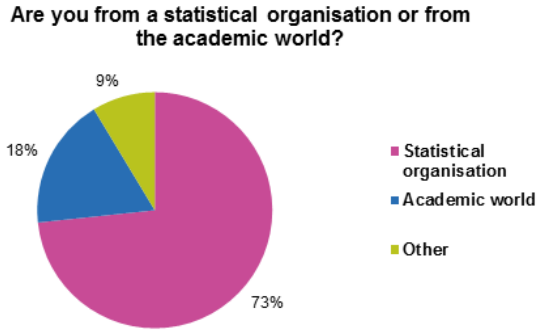
Timeliness / amount of papers
Content of the homepage
Meeting venue
Facilities at the venue
Overall organisation
Overall value of the meeting
Very good
Good
Satisfactory
Poor
(No response)


Which sessions in the agenda did you find most useful?
(more than one allowed)
35
30
25
20
15
10
5
0
Challenges of 'big data'
Implementing scanner data
Index theory and practice
Multilateral index methods
Issues with new data sources
Hedonic methods for HPIs
House price indices (HPIs)
Commercial property prices
Commemoration Peter von der Lippe
Property price statistics


Do you consider the poster session valuable?
1%
4%
95%
Yes
No
Do not know


How was the division of time between presentations and discussions?
4%
10%
86%
More time for presentations
More time for discussions
Good balance


Are you from a statistical organisation or from the academic world?
9%
18%
73%
Statistical organisation
Academic world
Other