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Handbook on Backcasting

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Introduction

Long time series are very important for analytical purposes and maintaining economic history of a country. Some of their uses include: modelling and forecasting, business cycle analysis, structural analysis, productivity analysis and other administrative uses.

Breaks in time series occur due to various reasons. They are brought about as a result of the adoption of new or updated international standards leading to changes in concepts, classifications, delineating institutional sectors, and sequence of accounts. They could also be introduced due to statistical revisions such as implementing new or revised data sources, implementing new interpolation/projection techniques and other methodological changes. Backcasting is a statistical technique employed to ensure the coherence of the time series across time while maintaining economic history of a country.

The global statistical community has adopted a new national accounting and classification standards, among others. These include the System of National Accounts 2008 as the international statistical standard for national accounts, the Fourth Revision of International Standard Industrial Classification of All Economic Activities (ISIC, Rev.4) as the international reference classification of production activities, an update from Revision 3.1 and the Classification of Individual Consumption by Purpose 2018 (COICOP 2018), an update of the of the 1999 version.

As countries adopt these new and related standards, there is a high demand for methodological guidance in applying backcasting techniques to maintain coherent timeseries. In this context, the United Nations Statistics Division (UNSD) has developed this handbook on backcasting national accounts, to provide national statistical offices with appropriate guidelines and advice. The handbook highlights the need, planning and implementation of backcasting national accounts statistics taking into account the different data and resource considerations required for the process, and articulate key steps such as analysing existing database, compiling new data sources, mapping old sources to new sources, and communicating with users, among others. The structure of the Handbook is based on the General Statistical Business Process Model (GSBPM).

Chapter 1: The Principles and Process of Backcasting

A. Introduction

1.1 National Accounting has evolved over the last few decades into data programs which are complex, integrated sequences of accounts that describe economic evolution of industry productive activity, commodity supply and use, distribution of income to/ by institutional sectors, use of income by sectors, savings which translate into investment in fixed capital, financial transactions and accumulation of wealth. While countries' programs vary in stages of development, all face the challenge of updating existing National Accounts on an occasional basis (as opposed to re-current data revisions to bring on more complete survey and administrative data over the regular preliminary to final data cycle) to move closer to international standards, update classifications, adopt new source data, etcetera. These types of revisions are a challenge due to the need to re-fit the whole integrated system with minimal disruption to the user community.

1.2 The uses of Macro-economic data require long time series. While SNA2008 provides the basis for the structure, concepts and definitions, classifications and sectorization, and the basis of accounting for these accounts, there is little guidance on the time series aspects of the database to be produced. The Data Quality Assessment Framework for National Accounts published by the IMF and endorsed by the UN Statistical Commission provides high level quality guidelines to produce National Accounts. Under the dimension on Serviceability, under Element 4.2 on consistency, states that statistics are to be consistent over a "reasonable" time period and when changes are made to the SNA database that "historical series are reconstructed as far back as reasonably possible".

1.3 The premise of this Handbook is to provide guidance on how to produce a consistent set of National Accounts for as long a time series as is "reasonably" possible. The book uses elements of the DQAF to set a framework for developing backcasted series, integrating them into a National Accounts framework, and verification tools to assess "reasonableness" of the results. The elements of a typical backcasting exercise are sorted into a taxonomy based on the "Methodological soundness" criteria from the DQAF. Backcasting techniques are developed using basic time-series methods for specific types of revision issues of the taxonomy. Integration techniques are proposed to pull the new time series into the specified accounts. Verification techniques are also proposed that are developed to assess the time-series integrity of the new database with the goal of preserving key attributes of economic history. Finally, the book recommends documentation of the revision to provide the appropriate information to the users to understand the revisions and use the database, and to future compilers to inform subsequent updates.

1.4 The book is structured based on a Business Process Model that was first adapted from the overall Statistical Business Process Model to reflect National accounting processes, and then an abridged version was created specific to the Backcasting process.

B. The need for long time series

1. The Uses for Historical Macroeconomic Data

1.5 Macroeconomic measurement has converged around the use of internationally accepted standards, but the efforts to comply are expensive and require high expertise to accomplish. The

decision as to how far back in time any updates are to be applied will be based on balancing the availability of resources with the needs of the users of the macroeconomic data.

1.6 The most intensive use of the National Accounts data is the monitoring and analysis of the economy in conjunction with the conduct of fiscal and monetary policy. In the global economy of today, consistent measurement across national economies is essential and therefore the international standards are key for international agencies like the United Nations, International Monetary Fund, Eurostat, the World Bank and Organization for Economic Cooperation and Development. Conformity to international standards is a major element in national accounts redesign projects. The other prevalent reason derives from the ongoing development and improvement of source-data products used to produce National Accounts.

1.7 While for the most part, monitoring the economy relates to the most recent or period, policy development also makes use of forecasts which are dependent on the use of long time series to estimate and project the dynamics of the economy. It is important that the database cover multiple economic cycles.

1.8 These types of analyses use infra-annual data (quarterly and monthly) when available and focus on GDP growth as the main indicator of the state of the economy but require at least the major accounts in the SNA Sequence of Accounts so that analysts can do a thorough assessment of what is driving the economy to evaluate any appropriate policy reaction.

1.9 Other uses of National Accounts data that require long time series include structural analyses such as studies of productivity or of structural change, which use the industry supply/use framework to produce growth accounting models of the economy. This type of work calls for long time series for the production accounts within the Sequence of Accounts – in addition to consistent measures of productive capital stock and labour inputs. Longer time series the production supply/use framework are also used in modelling environmental impacts of human activity on the environment.

2. Official Economic History

1.10 Ideally an NSO would refit the database as far back as the official record exists. This would facilitate all the uses of SNA data outlined above by ensuring that one consistent and complete dataset which document official macroeconomic history exists.

1.11 The reality is that statistical programs have evolved over time, and the detail, frequency and consistent quality of the data necessary to convert all the time series to the new concepts, definitions, classifications and accounting methods, will likely not exist for the entire time span of the pre-existing accounts. The most likely scenario is that NSOs update the SNA product line for the most recent time span and leave the historical period unrevised. The results in multipole breaks in the time series, and inconsistent measures of the important macroeconomic variables such as GDP, investment, savings and wealth. For the purpose pf this book, the current time period of compilation using the most up-to-date SNA standards along with the newest data sources and compilation techniques will be referred to as the “live” period or accounts while the unrevised data for past periods will be referred to as the “historical” period or accounts.

1.12 A problematic scenario for an NSO is that the user community is demonstrably unsatisfied with the length of time series provided after an update. This could lead to researchers doing their own backcasting of economic history for their own research purposes – resulting in multiple

versions. An equally problematic scenario is for an NSO to revise the entire economic history but by using "mechanical" techniques for distant time periods for which no new data exist and altering the past economic cycles as a result (dampening or amplifying) but not having an economic explanation to substantiate the changes. This can result in a loss of confidence in the whole dataset. This scenario could distort comparisons of business cycles across time due to "artificial" revision to the evolution of the economy.

1.13 Official economic history is important and needs to be maintained as a significant knowledge asset. The trade-off between the above scenarios needs to be managed carefully to maintain the value of the data asset. Given the importance of a system of accounts to measure economic performance, and that the key users for fiscal and monetary policy employ estimated models in their process, an official set of National accounts data should be backcasted with enough detail and long enough time series to facilitate this important work.

1.14 The work is best done by the NSO because National accounts compilers have specific knowledge of the data and data quality, structure of historical accounts and compilation methods that can be used to provide more accurately backcasted data. The specific methodological and statistical knowledge is very important to a backcasting process. The updated results need to be verified against established business cycle dates, tax and policy changes, economic structural changes like changes in regulation of various industries, and other aspects important to the economic history of a nation.

C. The Guiding Principles of Backcasting National Accounts

1.15 Determining the feasibility of the backcasting exercise requires some guidance to achieve the goal of providing users with long time series and consistent accounts of adequate quality so that the data can be interpretable in the historical economic context. The Data Quality Assessment Framework for National Accounts Statistics 2012 (DQAFNAS) developed by the International Monetary Fund to provide guidance on the qualitative assessment of National Account statistics is useful for setting up some principles for a National Accounts Backcasting exercise. Elements of the DQAFNAS are used and interpreted in the context of a backcasting exercise to set up some guiding principles.

1.16 The only specific guidance from the DQAFNAS on the issue of updating/backcasting the National accounts within the Serviceability element (4.0), specifically element 4.2.2 which states that:

Consistent time series data are available for an adequate period of time (at least five years).

1.17 Since this recommendation falls under "serviceability", an *adequate* period of time relates to the uses of the data as discussed under the need for long time series. The clause "at least five years" relates to the production of current quarterly estimates or the "live" period when at least five years of data is needed for seasonal adjustments and for analysis of the current trend/cycle.

1.18 For comparative analysis through time and modelling, more than five years of data are necessary. From a statistical point of view, a sample size of more than 30 observations is necessary for estimation of parameters of a model. From an economic point of view, the time series should cover several economic cycles (not just business cycles – but financial crises, supply or price

shocks for significant commodities, etcetera). The longer the time series, the better the model is specified. The rule of thumb for macroeconomic modelling is 20 to 40 years of quarterly data.

1.19 In a pure statistical sense, a *consistent* time series would refer to those which have been compiled using the same reproducible methodology over time. In the context of National accounting the recommendation that changes be applied for at least 5 years of data reflects to the need for at least that length of consistent time series to establish reliable estimates for seasonal adjustments for the recommended quarterly accounts – to adequately present current trends and cycles in the economic data. This would imply consistent methods for compilation for individual variables of the Macroeconomic database as well as consistent integration procedures to produce a consistent set of accounts.

1.20 If there is a long history to a set of national accounts, it is highly unlikely that the necessary data are readily available to completely recompile the accounts from the elemental variables up to the balanced accounts consistent with the "live" period. What is possible is to create longer time series by piecing together various time periods in the historical series by using backcasting techniques to reconcile the old to the new data and create a *reconcilable* time series, which accurately reflects the evolution of the variable over time in an economic context. These heterogeneous but reconcilable time series can then be used to produce balanced accounts which are also reconcilable but may require the use of an integration approach which is more appropriate to the quality and detail of the data for the backcasted period.

1.21 In this context, *reconcilable* means that the method used to create *consistency* either in a variable or a set of accounts are documented and published so that the old and new estimates are reconciled.

1.22 This issue is expressed well in "A mixed splicing procedure for economic time series" by Angel de la Fuente Moreno (2014, Estadistica Espanola, p.108) in the introductory paragraphs. "In order to construct long time series of economic aggregates, it is generally necessary to piece together several heterogeneous shorter series. Heterogeneity arises even in official national accounting data due to changes in benchmark years, which are often accompanied by methodological changes and by improvements in the quality of primary data sources and in estimation methods. …. The problem has no easy solution. National statistical institutes can (and sometimes do) help mitigate it by recalculating back series of key aggregates using current methods and criteria in conjunction with detailed source data for earlier periods, but even in this case there is no sure way to know how earlier estimates would have changed if, for instance, new or improved data sources had been available earlier on."

1.23 For a National Accounts backcasting exercise, the resulting database should be consistent over time in terms of concepts, definitions, valuation methods and classifications, but it may have been compiled using individual time series that are heterogeneous over time in terms of sources and methods and detail, as well as integration methods. If the economic history is consistent and analytically credible, the backcasting exercise will have been successful.

1.24 Another of the elements under "Serviceability" recommends:

When changes in source data, methodology, and statistical techniques are introduced, historic al series are reconstructed as far back as reasonably possible.

1.25 Determining what is *reasonably possible* is related to the potential quality of the results. Based on the DQAFNAS element 3.0: Accuracy and Reliability in the context of revised or backcasted data could be interpreted as follows:

Source data quality, reasonableness, frequency and timeliness

- Source data available provide an adequate basis to compile statistics. Source data approximate the definitions, scope, classifications, and valuation, and time of recording required. They are based on surveys or administrative records, the quality of which has been assessed and is documented.

1.26 In the context of backcasting projects for a set of Accounts, the ideal scenario is to find source data which at least approximate changes in concepts, definitions, boundaries etcetera. The further back in history, the more difficult it may be to find direct estimates of any specific issue. This leads to relying on methods other than direct compilation to push series and accounts back in time.

Sound Compilation or Backcasting techniques

- Data compilation employs sound statistical techniques to deal with data sources. Other statistical procedures (e.g., data adjustments and transformations, and statistical analysis) employ sound statistical techniques. The reliance on fixed ratios derived from benchmarks or other sources is monitored.
- Methods are used to preserve the economic significance of the time series qualities of existing National Accounts time series.

1.27 This element explicitly directs the backcasting technique to attempt to limit the use of fixed ratios wherever possible and to use direct data or proxy data and statistical methods that produce economically interpretable results. A backcasting exercise should not alter the cyclical nature of economic history unless the change is justified by a documentable phenomenon. For example, capitalization of research and development (R&D) expenditures by corporations should change the profile of real investment only when an acceleration/deceleration, increase or decrease in the phenomenon is documentable. The use a ratio at the last known data point to link R&D to total investment assumes that it occurred in the same proportion to other investment throughout history. This is a bold assumption, especially if it cannot be verified. It likely distorts the economic story of the past.

1.28 This does not imply that ratios cannot be used in a backcasting process. It means that ratios should only be used when no other corroborating data is available and that the assumptions underlying the ratio methodology are reasonable for interpretability of the outcome. These assumptions are discussed in chapter #.

1.29 Another element related to accuracy and reliability relates to the verification the backcasted historical data.

Sound validation techniques

- Assessment and validation of intermediate data and statistical outputs is part of the process. The data compiled from the main sources used to compile national accounts statistics are checked against other independent data sources. Statistical discrepancies in intermediate data are assessed and investigated and measures taken to remove them.

- A systematic procedure is used to assess the potential discrepancies in intermediate data.

1.30 This element refers to both the validation of data for the individual consistency issues, and the set of accounts which have been compiled using an appropriate integration method. The validation can also be done at the macro-economic level and discrepancies in the sequence of accounts can be addressed.

1.31 Accuracy and reliability of the backcasted set of accounts then depends on choice of the appropriate source data, the best conversion and backcasting methods and a thorough integration and validation process.

1.32 A successful backcasting project uses these DQAFNAS principles to assess the issues of inconsistency between the "live" and "historical" periods. The individual inconsistencies are addressed by researching possible data sources or proxies to be used in either direct estimation or in an appropriate backcasting method. The reconciled series are integrated into a sequence of accounts or an account using an integration approach which is appropriate to the availability and quality of the data. The results are validated through time series techniques and through economic analysis and the backcasting results and methods are documented and published. The length of the backcasting period will be determined by the length of the pre-existing National Accounts estimates, the availability of data available to reconcile the estimates to produce reasonable estimates and the results of the validation process.

D. The SNA and Backcasting Business Process Models

1. The SNA Business Process Model

1.33 The System of National accounts process is based on the standard Statistical Process model except tailored to the type of processes generally used in the compilation of accounts (which differs from the standard survey process) and to be used in update projects and ongoing production.

Table 1.1 SNA Generic business processing model

Overarching Management Functions Common standards, metadata and archiving processes Common registers and frames Management of data integration across agencies and programs Common processing Common Dissemination							
1	2	3	4	5	6	7	8
Specify Needs	Design	Build	Collect	Process	Analyze	Disseminate	Evaluate
1.1 Determine needs based on international standards/ requirements and user needs within institutional context	2.1 Design Output Structure – types of accounts to produce and frequency	3.1 Build input data processing systems and specify arrangements for transfer of data from source organizations	4.1 Select time period for transfer of input data files	5.1 Derive SNA variables from processed input source data including direct transformation, projectors, interpolation techniques etcetera	6.1 Prepare output files	7.1 Update output systems	8.1 Gather evaluation inputs
1.2 Consult and confirm needs with Macro economic analysis stakeholders	2.2 Design variable descriptions based on data availability and quality of input data	3.2 Build output data processing systems based on design of output product	4.2 Transfer needed input data files from sources	5.2 Integrate variables into Sequence of Accounts	6.2 Validate output files	7.2 Produce dissemination products	8.2 Conduct evaluation Using Data Output Quality Assessment Framework
1.3 Establish output objectives based on SNA2008 and Quality Assessment Framework	2.3 Design input processing methodologies for all source data	3.3 Test production system	4.3 Run input processing to transform inputs to SNA concepts, classifications and variable specification	5.3 Review, Validate and edit accounts using identities, supply use analysis and quality controls	6.3 Scrutinize and explain	7.3 Manage release of products	8.3 Agree on action plan
1.4 Check availability of data	2.4 Design Production system and workflow	3.4 Finalize Production system	4.4 Finalize input data gathering	5.4 Finalize data files	6.4 Apply disclosure controls	7.4 Promote dissemination products	
1.5 Prepare business case				5.5 Archive inputs, intermediate files and final accounts	6.5 Finalize outputs	7.5 Manage user support	

1.34 For regular SNA compilation of the "live" period of quarterly or annual accounts repeatedly follows steps 4 through 8 of the SNA-BPM processes represented in Table 1.1. The first three steps of the process are key to a large revision project which includes the type of updates that are done to adapt to new international standards or new data processing models like an Integrated Business Survey Program. Table 1.1 below demonstrates a more detailed version of the SNA-BPM developed for SNA purposes.

1.35 Any transformation of an existing set of National Accounts will likely be parsed into two projects; the transformation project to create the new SNA data, methods and structure to be used on an ongoing basis, and, a backcasting project to extend the new estimates and structure backward in time. The backcasting project would be based on backward estimation of the new sequence of accounts and variables from an existing set of balanced accounts – where source data detail may not be available for the past (only previously published aggregates) and where data for new variables may or may not be available for the entire timeframe of the existing accounts.

2. The Backcasting Business Process Model

1.36 Since the focus of this book is on the backcasting portion of the process, a slightly modified Business Process Model is proposed for that portion of the product.

1.37 This Backcasting Revision Business Process Model is based on the following assumptions:

a. A large-scale revision or transformation project is underway or has recently been completed transforming an existing set of SNA estimates and accounts to a new version with a specified set of changes or update issues;

b. An extensive consultation was done for the update process which included gathering information on the users' needs for backcasted time series

c. The new product includes a specified sequence of accounts which will have been compiled and balanced for a recent/current period. This product becomes the "benchmark" to base future estimates on but also is used as the link for the backward estimates; and,

d. The goal of the backcasting portion of the project is to provide as long consistent time series as is "reasonably possible" in line with the "new" SNA estimates.

1.38 The Backcasting Revision Business Process Model is an abridged version of the Generic SNA-BPM outlined in Table 1.2 below. There are four basic steps in the process: Assess and Specify; Build, collect, process and integrate; Analyze and Verify; and, Communicate and Disseminate results. These steps are derived from the accuracy and reliability criteria listed above starting with source data quality and reasonableness, sound compilation and backcasting techniques and sound validation techniques.

Table 1.2 Backcasting Revision Business Process Model

Overarching Principles of Backcasting Over Arching Quality guidance for re-estimation			
1.0 Assess and Specify	2.0 Build, collect, process and integrate	3.0 Analyze and Verify	4.0 Document and Disseminate
1.1 Review the old and new databases and identify consistency issues and sort into revision taxonomy for backcasting purposes. Create archiving system for all historical data including unpublished detail useful for backcasting purposes	2.1 Map data from old to new accounts for variables requiring no revision or backcasting.	3.1 Run a set of revision analyses by comparing new to old estimates. Set some parameters to identify outliers or problems based on standard revision analysis and expected outcomes of consistency corrections. Update variables that require corrections.	4.1 Prepare detailed explicit descriptions of each revision type including methodological notes, impact analysis and source data descriptions
1.2Assess source data availability for remediation of consistency issues in terms of data quality and potential backward estimation timeframe.	2.2 Prepare estimates for specific consistency issues, testing methods and assumptions. Check for reasonableness of results for the individual issues.	3.2 Verify overall account consistency by using standard analyses on key balancing entries (GDP, final expenditure aggregates, incomes, savings, investment, net-lending, and wealth accumulation for plausibility and consistency. Verify shift points due to key economic events.	4.2 Prepare analysis of overall impact of the revisions on key balancing entries.
1.3 Enumerate methodological options for backcasting the specific consistency issues including articulation of underlying assumptions and expected outcomes.	2.3. Document results in terms of final sources and methods and overall impact for backcasted variables	3.3 Analyse the revisions to the trend and cycle attributes of the overall economic history. Make sure that any changes are backed by an economic explanation.	4.3Disseminate results and publish revision analysis documentation mentioned in the two previous steps
1.4 Specify the scope of the backcasting exercise in terms of timeframes, detail, and types of accounts, based on an analysis of the assessment of all of the consistency issues.	2.4 Integrate data into new set of accounts using the pre-specified integration approach.	3.4 Correct any issues or problems and re-run aggregations.	
1.5 Specify the integration approach for the backcasting exercise considering objectives of preserving economic history.	2.5 Prepare databases of old and new data for comparison purposes and verification. Document significant economic events which should be reflected in both databases.		

E. Outline of the Handbook chapters

1.39 The remainder of this handbook roughly follows the structure of the Backcasting BPM. Chapter 2 outlines backcasting methods with recommendations on how to choose between alternative backcasting techniques and integration procedures. It describes various examples of how the generic techniques were employed by statistical agencies in re-fitting their accounts. It also recommends preparing comparative old and new databases to be used in validation processes. Chapter 3 discusses the specification of the backcasting project following steps 1 and 2 of the BBPM and uses a taxonomy based on the DQAFNAS to organize, specify and process the consistency issues. It identifies generic methodologies which can be used in backward estimation for individual consistency issues. It proposes the specification of time frames based on reasonableness and finally it describes integration techniques for re-compiling the accounts. Chapter 4, the Analysis and Verification step, outlines validation techniques for individual series and components of the key balancing entries. It also suggests some comparative analysis of the

economic attributes and cycles of the new and the old databases. Finally, Chapter 5 suggests the elements of a good dissemination document to be made available with the publication of the backcasted series.

Chapter 2: Backcasting methods

A. Introduction

2.1 This chapter presents various methods that can be used in a backcasting project. The methods relate to both the compilation methods for individual consistency issues as well as methods to integrate the backcasted data into an overall sequence of accounts.

2.2 A complex backcasting project that includes multiple types of consistency issues would likely make use of many backcasting techniques. Each consistency issue could be best corrected by one or more methods depending on the availability of direct data, corroborating data, or indicators or no data at all.

2.3 All statistical estimates of economic variables are based on assumptions. Assumptions about how the sample relates to the population that is being measured, or assumptions about the coverage of the administrative data or how the administrative data translates into the National Accounts concepts and definitions. Backcasting methods also have underlying assumptions. These assumptions relate to the trend or effect of the consistency issue in relation to the previously published estimates and on the accuracy of the data being used to mitigate the consistency issue. It is important to understand the underlying assumption of each backcasting technique in order to produce "reasonable" quality estimates.

2.4 Most National Accounts that are compiled over a longer time span make use of time series that are "heterogeneous" in the sense that the entire time spam has not been estimated using time series that have been compiled using the same estimation parameters or aggregation methods over time. National Statistical Offices have improved data collection techniques, statistical estimation procedures and use of administrative records over the years. Surveys go through redesigns where frame coverage is improved and the sample gets re-stratified or new commodities or industries are added. It is impossible and even undesirable to recompile the estimates for the back period, especially if the changes relate to newer economic phenomena that didn't exist in the past.

2.5 The main goal of backcasting is to find methods that can be used to link or transition the heterogeneous time series to create "consistency" so that the variables are interpretable from an economic point of view over the entire time span. This means that GDP and the other major balancing entries have been measured using the same concepts and definitions over time although the underlying data may be based on heterogeneous time series or even heterogeneous balancing methods.

2.6 The remainder of this chapter presents several methods that are useful in a backcasting project. It discusses that assumptions underlying these methods and presents some examples of when the method would be appropriate.

B. Backcasting methods consistency issues.

1. Bottom-up Estimation

2.7 Bottom-up estimation refers to compiling new estimates by building them up from source data components to estimate the variable or account in question. Bottom -up estimation is what is

usually done for the current period estimates, at least for the benchmark levels. Also, projector series are often built at the lowest level of detail and then aggregated.

2.8 From a backcasting perspective this may mean using a new data source for the back period and compiling the estimates using a bottom-up methodology. It could also include transforming the previously used data sources to the new basis using transition matrices or supplementary information and then compiling using the method which matches the new approach. In some instances, this could involve using micro data and a complete re-estimation process from the individual transactions or institutional units up to the aggregates.

2.9 In terms of quality – bottom up approaches usually produce the most robust results. This approach is often used for time periods that are not too distant in the past for which the source data is available in an electronic form and the quality is known.

2.10 Examples for use of bottom up could be a re-sectorization exercise to identify quasi-corporations and remove their transactions from mixed income and the household sector to the corporate sector. This would be best done by identifying the individual institutional units and aggregating the transactions with an appropriate weighting method.

2.11 Another example would be the compilation of Research and Development Expenditures using the GERD and BERD data collected by NSOs based on the Frascati Manual and building aa methodology to convert the data to the SNA attributes. This data often exists back to the early 60s on an annual basis.

2.12 This method might also be used when access to a previously existing set of administrative records becomes available for use by the statistical system from which National Accounts variables can be recompiled using detailed sources. An example could be newly acquired access to payroll data from the tax system that was previously not available and/or conversion methods had not been researched.

2.13 In some cases, a new methodology which caused a discrepancy between the old and new data, can be replicated using the old source data for the back period, but at a higher level of aggregation, or making use of some fixed parameters based on comparison of new and old data at the link point. This is still a bottom up approach – even though it is approximate. A discrepancy may still exist at the new benchmark point, but it is likely less significant, and a mechanical linking process can be used to piece together the old and new series without causing distortion to the economic significance of the data.

2. Retrapolation, Interpolation and Mixed Splicing methods

2.14 This section outlines a series of backward estimation techniques which can be referred to as mechanical splicing methods useful for piecing together old and new time series at the point where the discrepancy between the old and new is known. They are generally used when no direct data source is available to re-compile the variables on the new basis. They are based on knowledge of the source of the discrepancy between the new and old estimates and involve assumptions about the "persistence" of the phenomenon that is the source of the discrepancy over the historical time frame.

2.15 In this discussion it is assumed that there is an overlap year or number of years in the current estimation period relative to the previous estimates.

2.16 **Retrapolation** refers to backwards estimation using the growth rates of the old series on the new level at the link year or quarter. Retrapolation raises or lowers the level of the historical series in constant proportion over time. It can be done using a simple ratio calculation of the new to old series at an overlap period and using that ratio to extend the series back to the first recorded date . It maintains the growth of the time series but raises or lowers the level of the series, increasing or decreasing its weight in the aggregation hierarchy.

2.17 This method assumes that the phenomenon leading to the discrepancy persists for the length of the historical time series in constant proportion to the old series. This is a strong assumption. It should be used with caution. For example, if a new data source in the recent period showed that labour compensation estimates were missing for casual or intermittent employment under a low threshold, a new source shows that this represents half of one percent of the bottom quintile of the compensation distribution. Retrapolation would assume that this has always been missing in that proportion and add that fixed proportion to the bottom quintile for the historical period. If however, casual employment has been a growing or diminishing one phenomenon, or related to economic cycles or specific events or the value threshold has changed over time, the constant proportion assumption could be questioned.

2.18 **Interpolation** refers to extending a series backwards through a specific value in the past. It assumes that the discrepancy has been generated over the period of the time series. Since emerging economic phenomenon tend to grow over time, this method can be useful. It changes the growth rate of the original series by a constant fraction. This is appropriate when it is known that the starting point of the phenomenon was estimated using sound statistical procedure and the level at that year should be considered a benchmark.

2.19 This is the type of backcasting can be used between economic censuses or between redesigns of surveys where under coverage or a missing phenomenon has been revealed by the new estimates. In the example above, if the casual worker phenomenon was known to have been completely covered in the census year but has emerged as an issue in the intervening period, this technique would be reasonable.

2.20 **Mixed Splicing** offers an alternative between the two assumptions and gives the opportunity of using extraneous information to complete the backwards estimation. If the phenomenon was likely existing and not accounted for in the historical period but not likely in the same proportion over time, an approach of using some auxiliary information to estimate either the weight of the phenomenon in the total over time or the value of the phenomenon at T0 and maybe other intervening points, the interpolation could be used complete the time series.

2.21 If there is no auxiliary information, a simple approach of a weighted average of the retrapolation approach and the interpolation approach over time where the weights are designed to set a profile of the pattern of the discrepancy over time.

2.22 In the example above, if the phenomenon of missing wages of causal employment could be estimated at intermittent points from an economic census and then interpolated between the census estimates using employment statistics, then interpolation could be used to estimate the entire period by joining the new “benchmarks”. Or if there is no auxiliary information, the mechanical approach of weighting the interpolated and retrapolated results is doable.

2.23 These mechanical approaches are recommended for lower level series as opposed to aggregates. For example, a new survey could reveal that a five-digit level (COICOP) expenditure

item is missing in Household Final Consumption. Mechanical backcasting may be appropriate for this case. In the case of a source data change or redesign, it would be preferable to parse the discrepancy into details – such as a five-digit level or lower classification and then us backcasting techniques for the specific cases.

3. Backcasting changes or updates to classifications

2.24 There are many classification systems used in the compilation of a Sequence of National Accounts, which are outlined in SNA2008. Other classification systems are also used in National Statistics Offices. Some are administrative system based like trade statistics and some are local variants of industry classifications. As a National accounts program moves closer to SNA standards, it is often the case that classification changes are part of the update. Backwards estimation of time series for new classification systems is a challenge. The following generic approaches are based on a Eurostat Back Casting Handbook prepared to provide member countries with guidance on how to implement NACE Rev.2.

2.25 There are three basic approaches to use when backcasting a new classification system for a pre-existing database. They are referred to as the Micro approach, the Macro approach and the Micro-Macro approach. These are discussed individually below.

2.26 The **Micro** approach refers to have a double coding system whereby the individual units of measure are recoded from the old system to the new codes. It requires having a register of units that contains both the old and the new codes, over a period of time. If the estimates are some form of Census, it boils down to re-coding and re-aggregating. If the estimates are survey based, the data needs to be re-coded and then aggregates are re-estimated. In other words, re-code the in-scope units and re-run the estimation methodology. Transition matrices will be necessary to re-calculate the weights used in the re-estimation.

2.27 This is a highly accurate method in that the results are not dependent on any underlying assumptions beside the statistical assumptions behind any set of survey data. But it is data intensive, requiring access to micro data over the period. This is most likely only doable for a relatively short time span.

2.28 The **Macro** approach refers to converting data at an aggregated level by using a concordance file and a set of conversion coefficients. The first step is to create qualitative concordance files which list all the components in the new classes relative to the old classes and determine the one-to-one, many-to-one and one-to-many relationships. The second step is to create conversion coefficients to apply to the pre-existing estimates. This requires using the concordance tables with and overlap period that is either double coded at the micro level or using a variable recorded on the unit register, such as sales, assets, employment or earnings, to estimate conversion factors. The lower the level of classification this is done at, the more accurate the conversion the factors will be. The factors which are based on the estimated or measured allocation are then used to convert the back years' data at the lowest level of detail that is available. This method assumes that the ratios and splits estimated are stable over the period to which the factors are applied. It is a strong assumption and maybe only usable for a short time span or for updates to classification systems that are not drastically differing form old to new.

2.29 The **Mixed micro-macro** approach attempts to combine the two methods to inform the backcasting exercise. It refers to using several years of double coding and/or a number of years of

using a concordance to measure the conversion factors at a low level of detail. If the overlap of double coding shows a trend in changing weights within or among classes, then it is known that the use of one set of factors for the whole back period is not reasonable. Finding data for intermittent points in the back years is helpful to improve the backcasting exercise. For industry or commodity-based classification changes, pre-existing supply-use tables or input output tables could be used to estimate factors a several points in time and to establish a form of benchmark conversion for those specific years. Then transition matrices will be necessary to interpolate between benchmark years.

2.30 It is possible that when the backcasting exercise is completed the time series could have different segments: the most current or live years where the data has been estimated bottom up by coding the new classifications; a transition period where double coding exists at least at a reasonable level of detail; and, a historical period where fixed and or transition conversion factors where used on published aggregate (but not very aggregate) data. This would be what is referred to as a heterogeneous time series, but consistent in the classifications published and consistent in interpretability over time.

4. Modelled data approach

2.31 There may be consistency issues for which no directly measured data exist for the historical period, but there is data that is related or could be used in some form of modelling framework to create estimates. There are numerous methods under this generic approach and three generic ones will be discussed here: Chow and Lin type modelled data; the Supply-Use or Input-Output modelled data; and, Stock-Flow modelling.

2.32 The **Chow and Lin** modelling approach refers to using econometric techniques to establish a parametric relationship between indicator data and benchmark data and using the relationship to do backwards estimation. The original Chow and Lin papers (1971, 19) referred to modelling the error in estimation between projector data and benchmark data. The method can be generalized to create models that can be used for historical periods.

2.33 The method requires benchmark data for the so called “Live” or current estimation period and related indicator data available for some or all the backcasting period. The model is estimated for the current period and the estimated coefficients are used to create estimates for the back period. The method relies on the assumption that the relationship of the indicators to the estimate are stable over time and apply to the back period. This may be a strong assumption, but if the benchmark data exists for a reasonably long period of time, the assumptions could be tested to determine if the method will produce reasonable results or if there is a trend in the coefficients that can be built into the backwards estimation process. It is also a reasonable method for backcasting infra-annual data when only annual data exist for the historical period and a related higher frequency series exists. When using this to convert data frequencies then it is often combined with the Denton Method to create continuous series which have a smooth transition from one period to the next.

2.34 There are many types of national accounting issues for which this method or some variant is useful. If the goal is to provide a component breakdown that only exists in the current period, this could be applicable. For example, estimation of own-account construction activity when only benchmarks exist fir the type of construction. If employment and material use data exist for the back years, a modelled production function could be used.

2.35 **Supply-Use or Input-Output** modelling could also be used to do backwards estimation. It would require that some form of Supply-Use tables or Input-Output tables exist for some or part of the period. Supply-Use methods are useful for estimating either part of supply when use statistics are available or vice versa. Again, the method depends on the assumption that the Supply-Use relationship holds for the entire period. An example could be estimation of some types of production for the unrecorded economy when independent consumption statistics are available.

2.36 **Stock and Flow** modelling is another potential method for some backcasting purposes. The perpetual Inventory Model is often used by NSOs to estimate consumption of fixed capital at replacement cost valuation because business data were traditionally not recorded on that basis. The method also is used to calculate wealth on the National Balance Sheet. This method requires detailed investment flow data and information about asset lives and discard patterns as well as price statistics by asset type.

2.37 Other uses of Stock-Flow modelling could include imputation of property income flows from the stocks of financial assets and data on rates of return.

5. Satellite Account approach

2.38 The Satellite accounting approach is not so much a methodology as it is an approach for addressing a consistency issue that has potential impact on the whole sequence of accounts. It is a way to organize the work on a consistency issue and work through the methodological aspects of each variable. This is a particularly useful approach for asset or production boundary changes. It was used extensively for the capitalization of Research and Development Expenditures following the release of SNA2008. Since this boundary change had an impact on virtually every balancing entry from value-added right through to net worth, it was useful to test the methods for each of the variables in advance by using the satellite account approach. It also provides a platform from which to write a document that informs users of the potential changes related to the consistency issue.

2.39 The idea would be to set up a sequence of accounts for the boundary change issue, document the potential impact on each balancing impact and document the methodological approach to each stage in the accounts. The change could involve the use of many different data sources and statistical techniques involving several underlying assumptions. It helps the SNA compilers to prepare estimates for all elements of the issue in a coherent manner and to ensure that no steps in the sequence have been overlooked. This is useful even though some steps in the sequence are not calculated or published because it helps ensure consistency. The satellite accounting approach has been used extensively to produce estimates for Research and Development Capitalization.

6. Residual Estimation

2.40 Residual estimation refers to the use of National Accounting identities to fill in gaps for some new variables. This can be used for identifying a sub-sector that was previously imbedded in a higher-level sector or estimating a variable that can be isolated using identities in the system. There are generally assumptions involved in this type of estimation and the quality of the result will depend on the reasonableness of the assumptions.

2.41 An example could be in breaking out a sub-sector of the government sector where the sources of revenue are known (coming from other levels of government for example) and investment in fixed capital and direct transfers out are known. The missing variable is operating expenditure in this case. If the lower level of government has no borrowing authority, then it can be assumed that Net Lending is always zero and operating expenditure could be estimated as the residual.

2.42 This approach might also be used in a similar exercise to separate transaction of non-profit Institutions serving households out from the Household sector. If there is a restriction on the amount of revenues that can be accumulated by the sector without being spent in each time period, and current period data shows that the usual carry forward is a stable percentage of income, then savings could be imputed out of income using the percentage. The remainder must be accounted for by transfers out in cash of in kind and other operating expenditures.

C. Integration Methods for the backcasted sequence of accounts

2.43 Once the scope of the project is known, it is possible to look across the consistency issues and consider the best approach for integrating the backcasted variables into the sequence of accounts (see Chapter 3 on specification of the scope of the backcasting project). The choice of integration approach will depend largely on the scope of the project and what level of detail and which accounts are to be maintained in the back period. What follows here is a description of generic balancing approaches for the sequence of accounts in the back period.

1. Comprehensive bottom-up with re-balancing

2.44 For this approach the inconsistency issues have been estimated at the lowest level of detail using new sources, classification and backcasting methods and the accounts are re-compiled from the bottom-up. The integration process is completely re-done. If, for example, the usual balancing that was done for a current period benchmark year was to use detailed supply use tables as the tool to integrate the production, allocation and use of income and sector accounts, then the backcasting would be done for all the years of supply use tables at the detailed level and the re-balancing would be done the same as for the current period. This is a resource intensive approach and it may take too much time to accomplish. It may be doable only for a short time span – but may be desirable to maintain a completely rebalanced and consistent set of accounts for as long a period as possible. Five years of a fully balanced system is key to understanding the full implications of the consistency issues, especially for re-establishing quarterly data for seasonal adjustment.

2. Macro approach – prior integration maintained

2.45 Using the balanced set of accounts which were previously published, the new estimates of the consistency issues are super-imposed. This maintains the integration decisions of the past. It requires that the consistency issues be addressed in a balanced fashion. If for example, R&D expenditures are added to investment in fixed capital, production and value-added must also be re-estimated in a consistent manner. Growth rates and first differences for balancing entries like GDP are changed based on the corrected consistency issues.

2.46 This is a simpler approach and works well when the scope of the backcasting project is limited to a small number of interrelated issues.

3. Macro approach – maintenance of back period growth and trends

2.47 This is an approach whereby the integration of the accounts is constrained to minimize revisions to past period trends and growth rates of the major balancing entries and the integration adjustments are re-estimated to accomplish the result.

2.48 This approach is best when the backcasting of the consistency issues has been done largely using mechanical approaches, without adding much "information" or "news" in the process. This has the effect of correcting the level inconsistencies without changing the back-period economic story.

2.49 This is an expedient approach which is based on the assumptions of the consistency issues all having proportional effects in the back period and re-balancing to maintain growth patterns mitigates the impact of the consistency corrections on the interpretation of the back period economic evolution.

4. Intermittent benchmark approach

2.50 This approach is a mixed approach where a bottom up estimation technique is used to create benchmark years and the intervening period is interpolated using the previously published estimates as a base. This approach would be appropriate in cases where statistical systems are based on periodic comprehensive data systems such as economic census data. It is the equivalent of re-balancing at the periodic intervals maintaining trends or growth rates in the intervening period to the extent possible. This is a less resource intensive variant of the full bottom-up approach but has the advantage of having fully specified estimates of benchmarks for intermittent points in the back period.

5. Key measures re-balancing

2.51 Another approach that is often used for backcasting purposes is the use of one element in the sequence as the point for doing a detailed estimation of the back period and using that as a benchmark to re-integrate the whole system.

2.52 For example, if the consistency issues were all related to final expenditures, then the Final Expenditure approach to measuring GDP could be re-compiled and form as the benchmark and all the other elements in the sequence could be adjusted using an integration approach to be made consistent. Another frequently used tool would be the employment of a supply-use framework to re-integrate the accounts.

Useful References for Chapter 2.

1. Angel de la Fuente Moreno, "A mixed splicing procedure for economic time series , Estadistica Espanola, Volumen 56, Numero 183, 2014 pp 107-121

2. Backcasting Handbook, "Implementation of NACE rev.1 for EU", Eurostat, 2010

3. Jeff Tyndall, “Backcasting, Bridging, Parallel Runs and Seasonal Adjustment”, Australian Bureau of Statistics, 9th Meeting of the Advisory Expert Group on National Accounts, September 2014

4. “Backward Calculation of Dutch National Accounting Data Lessons from the Past: Towards a New Approach” Statistics Netherlands, OECD meeting of National Accounts Esperts, September 1999

5. “Data Quality Assessment Framework (DQAF) for National Accounts Statistics” International Monetary Fund, May 2012.

Chapter 3: Specification of the Backcasting Project

A. Introduction

3.1 An important step in a backcasting project is to organize the work at the onset. Up front work to search out and assess the quality of the data necessary for backcasting, specifying methodologies to backcast individual variables as well as setting methods for integrating the data into a set of accounts will facilitate the project process and minimize issues related to missing variables or integration problems late in the project. Upfront work to Specify the project is key to success.

B. Review and compare old and new databases

3.2 The first step in a backcasting exercise is to review the previously published database and enumerate all the changes or revisions that need to be done to create a consistent database for the entire timeframe for both the live and historical periods.

3.3 These "consistency issues" can be sorted into a taxonomy of revision. This sorting of the issues will facilitate not only the research into the source data and appropriate backcasting method but is also useful later for documenting and communicating the results.

3.4 In element 2.0 of the DQAFNAS on Methodological Soundness, there is a list of high-level topics for assessment of an SNA data program that would also serve as a good taxonomy for revision/consistency issues. Most update issues can be classified into one or more of the following categories. These categories are used in this handbook to assess specific consistency issues, identify backcasting methods, and validation techniques.

i. Concepts and definitions

3.5 Changing concepts and definitions used to compile the statistical series to be in broad conformity with guidelines outlined in the SNA standard.

ii. Scope (sequence of accounts, detail and frequency)

3.6 Modifying the National accounts to align with the sequence of accounts including the recommended elements and frequency suggested in SNA2008.

iii. Delineation of boundaries (production and capital)

3.7 Changing of production and capital/asset boundaries in line with SNA2008

iv. Classification and sectorization

3.8 Modification of classification and sectorization used in the compilation of national accounts

v. Basis of recording (valuation and timing)

3.9 Implementation of market price valuation and accrual accounting

vi. Reliability of compilation methods and source data

3.10 Adoption of updated compilation techniques or new and improved source data to compile the accounts

C. Identify the consistency issues and sort them using the taxonomy

3.11 The taxonomy serves to sort consistency issues at the project specification stage and associate possible data sources and potential backcasting methods for each issue.

1. Concepts and definition revisions;

3.12 Over the course of building a set of accounts, variables may have been estimated using data that approximated the SNA concept and/or definition. New data can become available to refine the estimates and become part of the regular compilation process. If the new data source is only available for current time periods a backcasting technique could be employed to make the variable consistent through time. Examples could be in-kind or non-wage compensation of employees, scrappage or used asset import adjustments to capital formation, or any other adjustment to render an estimate more compliant with SNA concepts and definitions.

3.13 These issues lend themselves to use of simple statistical techniques for backcasting such as retrapolation, extrapolation or a splicing method – all outlined in section 1.3, especially if the discrepancy between the new and old variable is small in proportion to the new level. Sometimes finding auxiliary information to backcast the missing phenomenon is necessary. Also care needs to be taken to ensure whether the added phenomenon is persistent throughout the backcasting period or a more recent issue.

2. Changes to scope (frequency, detail and structure of the sequence of accounts;

3.14 This type of update refers to adding an account to the sequence, such as adding Other Volume Change in Assets or Financial Accounts and Balance Sheets. This type of revision could also refer to converting accounts previously published at annual frequency on a quarterly frequency. It also refers to adding detailed components to previously published aggregates – usually final expenditure components such as the detail of household final consumption, gross fixed capital formation and/or international trade.

3.15 Since these changes are quite diverse in nature and scope, the appropriate methods need to be assessed on a case by case basis. Adding an account to the sequence can be a stand-alone backcasting project employing multiple backcasting techniques.

3. Updates or implementation of SNA classifications or sectorization;

3.16 Adoption of SNA classifications such as COICOP for Household Final Consumption or COFOG for Government Final Expenditure are often part of SNA update exercises. Updates to NACE or any other industrial classification are also included in this revision type.

3.17 Backcasting these issues usually requires creating crosswalks from some older classification to the new one. These crosswalks can be concordances with transition matrices or fixed-weight based depending on data availability. These techniques are outlined in 1.3.

4. Changes to production or capital boundaries;

3.18 As countries adapt their macroeconomic data systems to SNA2008 they often include capitalization of research and development, expenditures or military weapon delivery systems, capitalization of other military assets, capitalization of software development, and other intellectual property assets. The update could also include estimates of the informal, unrecorded or barter economies.

3.19 Changes like these involve complex projects to identify new data, establish estimation methods and develop benchmarks. Because the change can affect many variables in the whole sequence if accounts, the work is often done by establishing a "satellite account" in parallel to the official estimates and adopting the change when the methods have been tested and have been shown to be reliable.

3.20 Backcasting often involves finding enough historical data or related indicators to do backwards estimation of the variable(s). Multiple methodologies could be involved depending on the nature of the phenomenon and the types of available source data. These types of changes are best accomplished by using direct data or related indicators because they have the potential to alter the characteristics of the investment cycle and impact the balancing entries such as GDP, savings and net lending/borrowing and net worth.

5. Changes to accounting methods (valuation and timing of recording of transactions);

3.21 Source data used for National Accounting purposes does not always match the accrual principle or market valuation principles of the SNA. Modernization of accounting standards around the world is resulting in more and more data available that approximates SNA accounting methods. This can however lead to inconsistencies with historical data. Other variables need to be estimated on the SNA accounting basis (market value of non-traded assets, for example).

3.22 Methods for backwards estimation of accounting method corrections to source data are often model based, such as employing a Perpetual Inventory Method to estimate capital stock and associated replacement cost consumption of fixed capital. Modelling asset inflation is also used to revalue some types of assets. Accrual of incomes or tax revenues can be modelled based on the knowledge of the characteristics of the data or tax collection system.

6. Improvements in compilation methodologies and quality of source data.

3.23 National Statistical Offices are continually improving their data collection and compilation systems. More and more administrative data is used in conjunction with survey estimates and private sector databases are becoming more viable as sources of economic data. More recently NSOs have been moving towards Integrated Business Statistics Programs where a single frame of institutional units is maintained, surveys are designed and implemented with feeding National Accounts as an objective, and administrative data is blended in as much as is reasonable to minimize response burden and augment samples. As these new and improved data systems are implemented, they often produce estimates that differ in level and/or trend than past (often not as high-quality systems) produced. Any update of compilation methods in the SNA would likely produce a break in a time series as well.

3.24 Backcasting these types of changes is best done by using overlapping compilation periods (done on both the old and new basis) to establish a detailed reconciliation of old to new estimates. Once the relationships are established then backcasting techniques can be implemented to mediate the breaks and establish consistent estimates.

D. Review and Assess consistency issues for update potential

1. Research potential data sources for each consistency issues

3.25 This step involves researching for data which can be used to remediate the consistency issues. It is important to review the quality and the time periods of the data available relative to the timeframe of the pre-existing set of accounts. It may be the case that high quality data is available for the whole historical period or only for intermittent benchmark years. It could also be the case that new data of unknown quality is available for all or some of the period. In other cases, only related indicators or data that can be used to model the variable is possible. These attributes need to be assessed and documented to specify the backcasting period, methodology, and process.

2. Assess the quality of the potential source data

3.26 This is the stage to assess the source data relative to the DQAFNAS description of accuracy and reliability. This assessment will help identify the best backcasting method.

3.27 **High quality** source data approximates the definition, scope, classifications, valuation and time of recording as per SNA requirements, of the consistency issue in question. Especially when based on survey or administrative records for which the quality has been assessed and documented.

3.28 **Medium quality** data may come from survey or administrative records where significant transformation is required to meet the data attributes that the SNA requires (as listed above).

3.29 **Low quality** data could be available in the form of related indicators or only modelled, retrapolated, interpolated or spliced without use of auxiliary variables.

3. Sort the data sources into time frames related to the data quality

3.30 For any consistency issue, one or all three qualities of data may be available for all or parts of the time frame being considered for backcasting. This is important to note because it may only be possible to create a "heterogeneous" time series where each time period is estimated using different source data and differing methods. This approach can however produce a time series that is "consistent" in its interpretability as an SNA variable.

3.31 For each data consistency issue, sort the available source data into high, medium and low quality and document the time periods for which the conversion data is available.

E. Assess methodological options for each consistency issue.

3.32 At this point, knowing the data availability and quality it is possible to outline backcasting methods for each of the individual consistency issues including multiple methods for a heterogeneous approach. There are generic methods than can be employed which are described

below. But in each case, a methodology for backcasting involves assumptions, and these assumptions should be articulated to understand the quality of the backcasted series. Articulating these assumptions will also help to determine how far back in time a backcasting exercise should be carried. In conjunction with data quality and sound methods, the assumptions behind the methods are key in the determination of what is "reasonably possible" as outlined in the DQAFNAS. Without any appropriate data for the backwards estimation of a variable it may be preferable to leave a time series "break" that is documented than to risk distorting history using a mechanical approach which involves heroic assumptions that have no economic explanatory value.

F. Specify the scope and timeframe for the backcasting project as a whole

3.33 At this stage in the process, enough background work has been done on the various consistency issues such that a review should be done to set out the plan for the entire backcasting project. It is possible that the individual consistency issues have been reviewed/researched by different analysts based on their own expertise in compilation work and/or subject matter issues and a review across all the issues will be needed to finalize the project scope and timeframe.

3.34 The reliability of the backcasting exercise is founded on the quality of the source data used and the soundness of the backcasting techniques employed. One of the criteria on methodological soundness in the DQAF states that the reliance on fixed ratios should be monitored. This would apply for backcasting methods as well as projection methods. Looking across the various consistency issues will help National Accounts compilers to determine the tolerance limits for high, medium and low-quality estimates. Using a cross-issue review of the project, the overall quality objectives can be defined to decide what is meant by "reasonable" for the historical period estimation.

1. Analyze the timeframes and quality ratings across the various consistency issues

3.35 The goal of this analysis is to identify a time period for which the quality of the backcasted time series will be sufficient to portray the evolution of the economy and the various contributing sectors and activities in a manner which can be explained by the known economic factors of the time periods in question.

3.36 If there is an easily identifiable timeframe where the quality of the source data and the methodological soundness quality indicators are preponderantly in the medium to high range, this is a good indication of success for the backcasted product.

3.37 If on the other hand there is an identifiable period for which the backcasted product is based on a preponderance of low quality methods with little or no source data, this is a warning sign that backcasting, while seemingly making the data consistent in level or definition, there is potential to distort the economic story of that time period by using too many fixed ratios to do simple links.

3.38 If the prospective time period is long enough, it is likely that there will be distinct time periods which fall into the high, medium and low-quality rankings. It will be up to the NA compilers to assess the risk associated with each time frame and decide on how far back in time the exercise will produce "reasonably reliable" results.

3.39 Taking specific consistency issues out of scope for backcasting could be considered, especially those which add risk to the desired outcome. Having a break in a variable may be preferable to distortion of economic chronology.

2. Prepare a set of recommendations for the project as a whole

3.40 Prepare a set of recommendations on the specific constituency issues, timeframes and methods for the project which meet the selected quality targets. Finalize the scope and time frame for the backcasting project.

G. Specify the integration approach for the backcasted sequence of accounts

3.41 Once the scope of the project is known, it is possible to look across the consistency issues and consider the best approach for integrating the backcasted variables into the sequence of accounts. The choice of integration approach will depend largely on the scope of the project and what level of detail and which accounts are to be maintained in the back period. Generic balancing approaches for the sequence of accounts in the back period are discussed in Chapter 2 section III.

3.42 The final product of this phase of the BPM is a project plan which specifies all of the consistency issues to be corrected, the data sources and methods to be used in the process and the integration approach to produce a specified sequence of accounts.

H. Create a database system and implement the Backcasting exercise

3.43 After the review has been completed and the consistency issues are researched and documented, it is useful to set up a database structure for the unrevised data, the transition data, and the new revised accounts. After the review it will be known how much of the historical data can be simply transferred to the new database because it requires no revision. This is the first step of the backcasting process.

3.44 Create a database of the archived data. This step pulls all the historical databases into one structure. This facilitates comparisons of old to new data at the verification stage. The previously published estimates should always be maintained in an archive, even after the backcasting project is completed. It is important to keep a historical record of the various vintages of the National Accounts products.

3.45 Create supporting databases of unpublished detail used to compile previous estimates. These databases can be referred to as "quasi published" in the sense that they are the data necessary to reproduce the old accounts (but not necessarily micro data or survey records). These may be data estimates which were not published due to the "noise" content at the lower level of detail. These databases should be organized according to the aggregation hierarchy of the new system to be compiled. Axillary databases should also be created relating to the new data to be gathered to update the consistency issues. These quasi databases are the transitional data converting historical estimates to the revised, consistent ones.

3.46 The next stage is to backcast the consistency issues and recompile a sequence of accounts (or account, as the case may be) using the chosen integration method. The next stage will be the validation of the results. Data quality analysis and validation should be done on the individual

consistency issues before integration into a set of accounts. Validation techniques are discussed in Chapter 4.

I. Example of a review exercise for a historical backcasting project

3.47 The following is and example of a review and specification stage for a project to produce Final Expenditure on GDP and GDP by factor incomes on an SNA2008 basis for the period of 1947 to 1960 in the Canadian SNA. This review was done after the historical data had first been transformed to an SNA93 basis as the first stage of the project.

3.48 There are four consistency issues that needed to be addressed in this project. They are as follows:

a. Convert Household Final Consumption to the COICOP classification system to line the data up with 1961 onwards (classification change).

b. Separate NPISH final consumption from Household Final consumption (sectoring change).

c. Capitalize Research and Development for the Government and Business sectors and capitalize Military Weapons (boundary changes).

d. Switch to Fisher index Formula from the previous fixed-weighted Laspeyres indices for compilation of Real GDP (change in compilation method).

3.49 The research for update potential is as follows:

a. Although the published Household Final Consumption was very high-level, after some digging through the archives, the unpublished detail was identified in a deflation database. It was available quarterly from 1947 to 1961, both seasonally adjusted and unadjusted, on the same classification for which the concordance file had been used to convert the live period to COICOP. The earliest year for which a concordance file exists was 1981. That concordance file had also been used to convert the 1961 to 1981 data. It would be preferable to have earlier years for concordance. The likely outcome of using 1981 is that the data will be robust at the 3-digit level rather than the 5- and 6-digit conversion factors used, because of the emergence of new commodities over time.

b. The same concordance file used to convert to COICOP also identifies the NPISH elements buried in the historical HFC. Some research showed that data was available at least on an annual basis to revise the HFC payments to NPISHs, especially for University fees and direct payments to Hospitals for services. Universities and Hospitals are Non-profit Institutions in Canada. The question for sectoring is whether they are financed and controlled by Governments. They had been included in the Government sector form 19611 forward and research revealed that the major source of funding had increasingly come from Governments. They should be sectored in Final Demand to Government expenditures and not NPISH.

c. Research revealed the 1950s were a period of strong R&D growth in Canada in areas of Aerospace, Atomic energy, Agriculture and Fisheries and others. There was a policy by the Federal level of government to fund and encourage R&D. All business expenditures on R&D were tax deductible. Simple retrapolation techniques for these

variables would not likely produce economically interpretable results. A Royal Commission in 1961 studied the Federal Government's role in scientific research and the study provided detailed data for Government and business R&D back to 1950. Research also showed that the period prior to 1950 was concentrating on restoring industry after it had been commandeered during the war effort of the Second World War. Not much R&D was done during the 1947 to 1949-time frame. The backcasting method would be to concord that data to the published R&D at 1961, and then convert it to quarterly data using a cubic spline technique.

d. For capitalization of weapons, Annual totals of Federal Government expenditure on military capital were available from survey data back to 1940. Since Construction and machinery and equipment expenditure had been identified in a deflation database, the residual was likely weapon systems. The Quarterly pattern could be modelled from the quarterly data of the other components of military capital.

e. Finally, the move to use Fisher index formula for aggregation of Final Expenditure GDP would make the REAL GDP growth rates consistent over time. Since the HFC, NPISH and Gross Fixed Capital formation final expenditures were all being converted to the classifications used for 1961 forward. This looked feasible if there was enough detail for inventory investment to be calculated on a consistent basis. The necessary data was identified to do the conversion.

3.50 The final consideration was to balance the Income and expenditure approaches to calculating GDP. First, the Business R&D expenses would have to be added back to net operating surplus. The new consumption of fixed capital would have to be calculated for Government and business. This could be done using the Perpetual Inventory Model used in calculating the CFC estimates for 1961 forward. Since the adjustments for consistency issues effected both income and expenditure-based GDP equally, the integration method to be used would be to maintain the previous balancing. (In Canada a discrepancy between income and expenditure-based GDP is calculated and half is added to the lower estimate and half is subtracted from the higher estimate to arrive at one GDP estimate in nominal terms.)

3.51 The recommendation was that the project was feasible in that it would produce consistent time series for Income and Expenditure-based GDP of reasonable quality. Because of the vintage of the COICOP conversion and the need to do modelled or smooth conversions from annual to quarterly, and that the conversion came from actual data on the boundary issues. the database is in the medium-high quality range. Once this project was complete, a study should be done to assess the feasibility of producing the current and capital accounts for the Institutional Sectors.

Chapter 4: Analyze and Verify

A. Introduction

4.1 In this phase of the project final validation of the backcasted results is done for both the individual consistency issues (some validation has already been done in the estimation stage), and for the overall accounts and balancing entries. The analyses performed are statistical, economic plausibility and national accounts consistency: statistical analysis is used to identify outliers or to document the impact of a change; economic analysis to either explain or question the revision results, and to test the plausibility of the revisions based on knowledge of the economic events of the past; and, national accounts consistency analysis verifies all of the identities and consistencies across the sequence of accounts. At the end of the validation stage, the database should be a consistent database through time which accurately reflects the evolution of the macro economy.

B. A Priori expectations

4.2 Before performing the analyses, it is useful to make notes on the expected outcomes of each consistency issues and for the aggregate variables in the accounts. Should the backcasting process effect the growth rates or levels in a significant way or not?

4.3 As part of the validation process, it is useful to look at the revisions to both individual issues or overall aggregates in terms of the "news" versus "noise" content. This news or noise view of revisions stems from research done in the context of the use of the National Accounts data for policy analysis. This research used real time databases (successive iterations for each time period of SNA data throughout the revision process from preliminary to final) to classify revisions into "news" or "noise". The revision is "news" when the revision itself is correlated with the new or revised estimate and it is "noise" when the revised data is correlated with the unrevised estimate and the revisions (new – old) are statistically "noise". In the context of the usual revision process of National Accounts estimates from preliminary to final (when all of the relevant source data are available), if the revisions are "noise" the methodology used to compile the preliminary estimate is "efficient" but if the revision is "news" it means that there is information in the revision that effects the trend or level of GDP, and could be the result of a predictable bias. In this literature the use of the analysis was to build "bias" estimates into the modelling process used in policy work.

4.4 As pointed out in Fixler (2007), this approach to testing revisions for news or noise is also useful for national accounts compliers. It can be used to determine compilation issues that need to be addressed to improve the "efficiency" of preliminary estimates.

4.5 This characterization of revisions is useful to the validation of a backcasting exercise in two ways. First any given type of revision (boundary change, classification change, valuation change, etcetera) is inherently either a news of noise type revision. If a revision is prima facie a noise type revision but the results have affected trends or levels, then the revisions need to be investigated.

4.6 For example, a change in classification which simply re-uses old data mapped to a new classification, prima facie is a "noise"- type of revision. It should not change the level or trend of GDP or the aggregate to which the reclassification applies, and the revised data should be highly correlated with the previously published data. A change in the asset boundary, such as

capitalization of software or research and development would be a "news'- type of revision for the estimates of business investment expenditure and potentially for GDP depending on the magnitude and significance of this type of expenditure to the economy. The revision should be "noise" for GDP in the case of the government sector because software or R&D expenditures previously recorded as current expenditure (but still a final expenditure) of the government sector, and news for government final investment expenditure.

4.7 Second, determining that a revision is either news or noise helps to set thresholds for identification of outliers when doing statistical analysis of the backcasted results. The outliers could be the results of the methodological process which may be unintended, or they may have information content related to the subject matter being revised (such as a strike or policy change that affected the new information source).

4.8 All revisions should be explainable from an economic point of view. Changing the pattern of growth in the economy in history due to a technical issue (simple retrapolation or interpolation for example where the underlying assumptions cannot be validated) is not credible. The compilers of the original versions of these accounts had good knowledge of the economic conditions, events and institutional factors existing at the time the estimates were originally compiled. Ex post changes that have a significant effect on key aggregates should have a specific effect due to a new source of information or due to a discovery of errors or problems in previous estimates or be based on a reasonably verifiable set of assumptions. "Noise" type revisions should be carefully managed to maintain the economic history. "News" type revisions should be verified by historic fact.

4.9 Finalize a list of expected results, news or noise, for each consistency issues addressed in the backcasting process.

C. Statistical Analysis of the revisions

4.10 The aim of this stage of the validation process is to look at the statistical impact of the correction of the consistency issues on the important variables and balancing entries of the accounts. For example, if the asset boundary was changed, the statistical analysis would look at the revisions to gross fixed capital formation and the effects of that revision on balancing entries such as GDP, net lending/borrowing and net worth. If classification systems were changed, then statistical analysis of the components affected, and balancing entries should show very little revision in trend or level. The best approach at this stage is to run statistical analysis of the revisions to the key balancing entries, identify outliers and drill down to the individual consistency issues to explain the change.

1. Comparisons to the previously published data

4.11 3.2.1 Run a set of comparisons to the previously published data and look at the revisions to growth rates (or levels if it is deemed to be a useful exercise) using the files created at the end of phase two. This statistical analysis is simply to compare the properties of the growth and trends of the major economic signal variables before and after the backcasting process. (This is not the same type of analysis used to look at revision vintages over the regular data cycle – which produce "revision triangles".) The tables below suggest a set of summary statistics to compile for each variable that is the focus of the analysis.

4.12 Simply graphing the new and old results is extremely useful. Putting together a few summary statistics of the revisions will help to document the change and reveal any outliers or errors. When backcasting, it is most useful to analyze the changes to the growth rates of the relevant series. Table 4.1 presents a few examples of useful summary statistics.

Table 4.1 Summary statistics of growth rates and revisions to growth rates for each relevant variable

Growth rate or revision to growth rate	Pre-existing estimates	Revised estimates	New – Old Growth rates	Purpose of summary statistic
Mean				Indicates average growth over the historical period
Mean Absolute				Indicates averages growth without offsets of positive and negative
Standard Deviation				Estimate of the dispersion of the growth rates
Minimum value				Lowest growth rate
Maximum value				Highest growth rate
Range of 90% of values				Used to identify outliers – which may have economic significance
Cumulative Revisions or growth rates				Graph over time to find periods of news and noise

2. Assess the "reasonableness" of the overall results

4.13 Using the summary statistics calculated, to assess the "reasonableness" of the overall results.

4.14 Use the range of 90% of values to identify outliers. This could be set at 95% or 99% depending on the tolerance for revisions. Any growth rates or revisions outside the threshold should be investigated.

4.15 Use the Median and Mean to calculate the skewness of the old and new results and the revisions. If corrections to consistency issues are largely noise-type revisions, then there should be no change in skew or no skew in the revisions. News-type revisions should result in a skew in the revisions in the direction of the news such as more growth or less growth.

4.16 Graph the cumulative revisions to growth rates to identify runs in positive or negative sign or whether the revisions are generally noise. This is useful for analysis of revisions which incorporate new data sources or methods. It gives a very quick and visual impression of the impacts of the changes to overall aggregates. It can also pinpoint problems if unexpected runs of revisions occur in the time period.

4.17 Correct any outliers which were caused by process issues or are not reasonable in an economic context.

D. Validation of overall National Accounts consistency.

4.18 Validation of the National Accounts consistency of the project amounts to testing the important aggregates and variables for consistency using identities of National accounting. This step verifies the integrity of each portion of the sequence of accounts and the balancing entries in relation to each other.

1. Residuals and Balancing entries

4.19 There are different approached used to balancing a sequence of accounts and arriving at key balancing entries such as GDP, saving, net lending etcetera. The approach chosen in the specification will, to some degree determine what verification needs to be done in this step of the process.

4.20 If the overall approach to the project was to rebalance the system after backcasting the individual consistency issues and compiling the system of accounts, then it is likely that all of the national accounting identities have been used to set the totals by using residuals which are then allocated using some sort of algorithm (perhaps weighting by component or by quality ranking). In this case it is not necessary to check all of the accounting identities because they are prescribed by the system. In this case validation should move directly to the economic validation stage the check the plausibility of the results. For this type of balancing, it is important to check that the allocation of the discrepancy does not significantly alter the economic interpretation of the data.

4.21 If the approach to balancing the accounts is to leave some discrepancies in the National Accounts identities, then they need to be checked. Large discrepancies, especially if the previously published results were largely consistent across identities will produce in less credible results. In this case, and in cases where parts of the system are not balanced by technical algorithms, the following consistency checks are useful:

- Check the relationships between GDP by sum of final expenditures, by sum of factor incomes and by sum of industry value-added.
- Check the sum property income flows across sectors. Flows to and from should balance out to the net non-resident flows.
- Check the sum of transfer payments across sectors. Paid and received should balance.
- Check that the sum of Net-lending/borrowing balance across sectors after accounting for any unallocated discrepancies.
- Check that saving equals investment.
- Check that Net financial investment equals net lending by sector (plus some discrepancy).
- Check that net financial investment or net lending plus other volume changes in assets by sector add the change in net worth.

2. Economic Analysis techniques

4.22 In terms of economic analysis of the results, the same validation techniques that apply to the regular production of National Accounts data should be done for the backcasting process. This technique involves using economic relationships and ratios for "reasonableness". The following are examples of these types of data checks.

a. Use of analytic ratios

4.23 The following are examples of types of ratios that can be analyzed for consistency:

- Components of final expenditure to GDP or of Income to GNI
- Ratio of taxes to tax bases (income tax to incomes, Vat taxes to expenditures etcetera)
- Supply/use ratios and Value-added to Output ratios
- Plausibility of the Household and National saving ratio
- Comparison of Final expenditure price indexes to Producer Price indexes etcetera
- Debt/equity, debt to income or debt to net worth ratios
- Trends in investment, government spending, corporate profits, net lending of sectors and other major variables of the SNA

4.24 In most cases the ratios should have some measure of stability over time or gradual shifts. Some ratios could have shifts due to changes in policy such as the introduction of a value-added tax or an explicit shift in monetary of fiscal policy.

b. Verification of special economic events.

4.25 Checking database for known economic events to ensure that major events are well represented in the newly backcasted data set, such as

- Strikes
- Large acquisitions and takeovers
- Demutualization of life insurance regimes
- Changes in pension regimes or introduction of national pensions
- Tax policy shift (addition of a VAT, changes in deductions or other rules)
- Nationalization or privatization or regulation or deregulation of industries
- Addition, change, or deletion of national welfare programs like universal health care or national pensions
- Major storms, droughts, or other weather-related catastrophic events

c. Analysis of Economic Cycles

4.26 Economic cycles are an important part of Macroeconomic analysis. It is important to verify any revisions to those cycles. Cycles could be amplified or dampened due to the choice of backcasting methods when there is a paucity of data on the issue and simple linking methods are used.

4.27 An analysis of the pre and post-revision growth patterns is useful to identify any potential problems. Table 4.2 presents s statistical approach to analyzing the revisions to the economic cycles.

Table 4.2 Summary statistics of economic cycles

Growth rates	Pre-existing estimates	Revised estimates	New – Old Growth rates	Purpose of summary statistic
Growth profile				
Percent positive rates				Percentage of expansionary periods
Percent negative rates				Percentage of contractionary periods
Trend Profile				
Percent of accelerations				Percentage increasing of growth trend
Percent of decelerations				Percentage decreasing of growth trend

4.28 Use the percentage of expansionary and contractionary time periods and to the accelerations and decelerations to assess whether the economic cycles have been altered. If the cycles have been dampened or accentuated, determine the extent to which this has been the result of mechanical revision practices or new information and whether this is a credible result.

4.29 Verification and/or validation is an iterative process. Once potential problems or discrepancies have been addressed, a new set of statistics should be calculated to use in the documentation phase of the project.

Chapter 5: Documentation and Communication and Dissemination

A. Introduction

5.1 Over the stages of a backcasting project, there are many opportunities to document and communicate the project process, methodology and results. This chapter explores the need for good communication with stakeholders and good documentation of methods and results. Since most backcasting projects are backward extensions of larger update projects for the National Accounts, a lot of information explaining the purposes of the changes to the accounts will already have been published. The goal of the communication strategy for the backcasting piece is to document the source data and methods of how the consistency issues were dealt with and to present analysis of the revisions to the so called "maintenance" period to help users understand the impacts of the changes.

5.2 A lot of information pertaining to the list of consistency issues has been gathered and documented along the course of the backcasting exercise. This stage of the project gathers all of the information into two types of documents; documentation of individual consistency issues and results which should be archived for use by compilers in any future revision exercise, and, an overall report on the backcasting project summarizing the consistency issues and the overall balancing methods including analysis of the impacts of the revisions, which should be published for users.

B. Documentation for consistency issues.

5.3 4.1The first step is to gather together the information on each "consistency issues" from each stage of the process and prepare a summary document of all the specific changes made to correct consistency issues.

5.4 Any working papers prepared during earlier phases of the project or as part of the larger update process of the National accounts could be edited to include the backcasting portion of the project and prepared for public dissemination. Papers on specific topics like a change in classification which explains the objective of the new classification and the method(s) use to convert the time series are particularly useful for detailed users of the accounts who need to retool their own systems (databases, models or analytic products) because of the update of the SNA product. Adding the details of the backcasting exercise also helps document the segments of the entire (likely heterogeneous) time series.

5.5 The use of a "satellite account" approach to estimate and backcast a change or correction of an inconsistency, provides a comprehensive documentation which could explore methodological options, examine a range of results – sometimes related to varying quality of source-data options. This type of document is as useful for compilers as it is for users. Publication of this type of work could be useful to the National Accounting community and is an excellent professional opportunity for National Accounts compilers.

5.6 Since the goal of this stage of the process is to document all the consistency issues addressed, if there are no working papers or satellite account projects to draw on, the use of a template to document the issues would greatly facilitate this step of the process. A suggested template is presented here.

Table 5.1 Template for documentation of backcasting consistency issues

Documentation of backcasting revision issues, sources, methods and results
Revision topic description
Revision issue such as adoption of COICOP or capitalization of Research and Development or implementation of new source data results. Any notes on background to the issue should be provided here.
Data Sources, time periods and quality
This section should document the attributes of the previously published data as well as the proposed backcasted data including time series length, source data, breakdowns available, quality assessment rankings (these attributes may need to be documented into time series segments).
Backcasting Method(s)
This section documents the backwards estimation method(s) used for the specific consistency issue including any underlying assumptions implicit in the method or explicit.
Results
Presentation of backcasted series with comparison to old series or aggregates. Graphic presentation is useful.
Validation of results
Presentation of results including both qualitative interpretative analyses. For example, in the case of R&D capitalization this could include analysis of the impact on GDP or on National Wealth. It could also include discussion of economic trends such as a cycle of aerospace, high-tech or pharmaceutical R&D found in the historical period.

5.7 At the end of this stage, the consistency issues have been documented individually and that information could be used to update public National Accounts documentation such as sources and methods documents. At the very least, the template documentation suggested above would be archived for future reference for National Accounts compilers.

C. Documenting the overall backcasting project.

5.8 The purpose of the overall backcasting project report is to summarize the project and document the change-over from the previously published set of accounts to the new consistent set of accounts. The best practice would be to prepare such a document for publication on the NSO website so that users are able to access the information on how the data were re-estimated to obtain consistency.

Table 5.2 Template of the final report of the backcasting project

Final Report for backcasting project
Objectives of backcasting exercise
Objectives of backcasting exercise This section documents the outcomes of the project as defined in the original objectives which would be to create consistent time series and or accounts over a given time frame. It would outline which accounts or sets of time series were the target of the backcasting exercise and over what period and explain the bases for the choices made in terms of scope and timeframe.
Overall approach to backwards estimation and integration
This section outlines the overall approach chosen in terms of backcasting and integration methods. For example, It would state that the overall approach was to build new estimates from the detailed data up to the aggregates wherever possible and to minimize the amount of "mechanical" backcasting or use of fixed ratios. The goal would be either to bring all estimates in line with current benchmark levels or to maintain the growth pattern of the past. The reasons for the choice of overall methods and approaches.
Analysis of results of the backcasting process
This section presents the analysis of the newly backcasted data from an economic perspective. Are there any changes to the patterns of the economy and the allocation of incomes across sectors or the accumulation of wealth? If the impact is small – the effect of the overall revision is "noise", but there could also be "news" depending on the type of revision done and the new information used. Any revision to previous economic cycles or trends should be noted and explained with economic rational. For example, it could be the case that in capitalizing R&D expenditures, there was a net increase in growth of the economy and wealth over a specific period that was related to a period of intense aerospace (or pharmaceutical or Information technology) investment. This analysis is summary information from the validation exercise done to confirm the overall results.
Discussion of consistency issues and results of each
This section should summarize the individual consistency issues addressed or at least the major consistency issues. For each issue it would include a brief description of the issues and a brief overview of the sources, methods and results. This draws heavily from the detailed documentation suggested above. The paper could include (for completeness) an appendix which includes the template information on all of the consistency issues.
Presentation and analysis of revisions
This final section presents a statistical analysis of the revisions. It should include many of the summary statistics used in the validation process to characterize the results. This type of analysis serves two purposes; first it helps the users to gain confidence in the new data, and second, it documents the effects of the specific backcasting exercise to distinguish these revisions as different from the regular revision process. This is important so that users and compilers do not lump these revisions in with the regular revision practices when looking at issues of bias. It could lead to a false impression of the regular data cycle.

D. Examples of Communication Output of a Major update and backcasting exercise:

5.9 The Bureau of Economic Analysis uses this type of communication strategy to complete its strategic revisions. Up until recently, the US BEA published regular 5-year interval comprehensive revisions to the National Income and Product (NIPA) Accounts. These revisions incorporated data from the 5-year economic census and the BEA used the opportunity to update concepts, classifications, methodologies etcetera. The plan for the 2013 comprehensive revision started shortly after the publication of the 2009 version. The documentation and communication included the following elements:

a. The BEA published research on several issues such as treating research and development expenditures as gross fixed capital formation, treatment of artistic originals as assets and the accrual of defined pension plan benefits. Over the course of 2009 to 2012 and early 2013, seven substantive research and background papers were published on the issues relating to the treatment of these phenomena in the NIPA.

b. In early 2013 and article was published called "Preview of the 2013 Comprehensive Revision of the National Income and Product Accounts" in the May 2013 issue of the Survey of Current Business (27 pages). This was a substantive article which described the upcoming changes in full including source data to be used and methods. It outlined the timeframes of each of the revision topics including backcasting sources and methods.

c. In addition to this the BEA prepared a detailed briefing of the upcoming revision, including most of the information in the published article – but in bullet point, slide presentation form (75 slides). This presentation was available on the BEA website, and the officials of the NIPA also gave the briefing to key stakeholder groups.

d. Later in July of 2013, the results of the revision exercise were published with a brief news release.

e. A new set of briefing slides were prepared which were quantitative in nature – showing the effects of the various changes to the NIPA accounts and economy measures mostly in graphical form (60 slides).

f. Finally, a paper summarizing and explaining all of the changes was published in the September issue of Survey of Current Business called "Improved estimates of the National Income and Product accounts - Results of the Comprehensive Revision of 2013" (45 pages). This paper documented the published revision results including tables with detailed explanatory notes.

5.10 The links to these communication pieces can easily be accessed on the BEA the website. While the overall communication strategy is excellent, backcasting methods were not always easy to find – even though the accounts were revised back to the year 1926.

5.11 Other countries have communication documents outlining the plan, the upcoming changes and then the results. None are as comprehensive as the US approach. It is very helpful that the US BEA uses and electronic journal, "The Survey of Current Business" as its main communication tool. This is a convenient way to publish and store the results in an accessible way so that users can easily find the articles through a search engine.

References

Handbooks and Manuals

1. Guidelines in Integrated Economic Statistics, United Nations, White Cover Paper, 2011http://unstats.un.org/unsd/nationalaccount/ies/
2. *A System of National Accounts 2008, European Commission, International Monetary Fund, Organization for Economic Cooperation and Development, United Nations and World Bank, New York, 2009*http://unstats.un.org/unsd/nationalaccount/sna2008.asp
3. Handbook on Quarterly Accounts, European Commission, Eurostat, 1999, https://ec.europa.eu/eurostat/documents/3859598/5936013/KS-GQ-13-004-EN.PDF/3544793c-0bde-4381-a7ad-a5cfe5d8c8d0

Pre and Post Revision Information Papers and Revision Management Papers

1. Revision of Dutch National Accounts, Gert Buiten, Jacqueline van den Hof and Peter Van de Ven, Statistics Netherlands (NA91), Voorburg, 1999 https://www.cbs.nl/NR/rdonlyres/925A8C83-57FE-4C01-8989-7B56804562AC/0/1999091p30pub.pdf
2. Revision 2014, Danish Major Revision and Implementation of ESA2010, Annette Thompson and Soren Broderson, Power Pont Presentation to OECD Working party on National Accounts, fall 2013,www.oecd.org/std/na/48851307.ppt or info on Statistics Denmark website https://www.dst.dk/en/Statistik/dokumentation/hovedrevideret-nationalregnskab/hovedeffekter-af-revisionen.aspx
3. Implementation of System of National Accounts 2008 and Balance of Payments and International Investment Position Manual 6th edition by the Australian Bureau of Statistics, Michael Davies, ABS Power Point Presentation , OECD Working Party on Financial Statistics, October 2011
4. Improved Estimates of the National Income and Product Accounts, Results of the 2013 Comprehensive Revision, Stephanie H. McCulla, Alyssa E. Holdren and Shelly Smith, Survey of Current Business, September 2013, BEA Washington
5. Canadian System of National Accounts 2012 Historical Revision, https://www.statcan.gc.ca/eng/nea/hr2012/start
6. Managing the implementation of the SNA, BPM and related international standards in s National Statistics Office context. Derek Cullen and Bernard Williams, IFC Bulletin No. 33 https://www.bis.org/ifc/publ/ifcb33a.pdf
7. Backward calculation of Dutch National Accounting, data lessons from the past: Towards a new approach, G.P. Bakke and A.M. Rooijen, OECD September 1999 (STD`NA(99)39https://www.oecd.org/std/na/2681263.pdf
8. Retrapolating Italian Annual National Accounts According to ESA95,L. Bracci, F. Di Leo and S. Pisani, ISTAT 1999,https://www.oecd.org/std/na/2681239.pdf
9. Improving BEAs Accounts through Flexible Annual Revisions, Survey of Current Business June 2008,https://www.bea.gov/scb/pdf/2008/06 June/0608_flexible.pdf

Individual revision topics and methods

1. Research and Development Satellite Account, U.S. Bureau of Economic Analysis, several papers leading up to R&D capitalization in NIPA, 2007 to 2013, https://www.bea.gov/ search R&D capitalization in NIPA
2. Preview of the 2009 Comprehensive Revision of the National Income and Product Accounts, New Classifications for Personal Consumption Expenditures, Clinton P.McCully and Teresita D. Teensma, Survey of Current Business, May 2008 https://bea.gov/scb/pdf/2008/05 May/0508_nipa_pce.pdf
3. Methodology for backcasting revision to 2007 and 2008 for the Input Output Accounts, Statistics Canada, May 2014 http://www.statcan.gc.ca/imdb-bmdi/document/1401_D13_T9_V1-eng.pdf
4. The Canadian R&D Satellite Account 1997 to 2004, Income and Expenditure technical paper series Number 56, Statistics Canada May 2008 http://www150.statcan.gc.ca/pub/13-604-m/13-604-m2007056-eng.htm
5. Retrapolating Italian Annual National Accounts According to ESA95,L. Bracci, F. Di Leo and S. Pisani, ISTAT 1999https://www.oecd.org/std/na/2681239.pdf
6. Alternative Measures of Implicitly Priced FINANCIAL Services of Savings Institutions and Credit Unions, Kyle K. Hood, Survey of Current Business, November 2013 www.bea.gov/scb/pdf/2013/11%20November/1113_finance_services.pdf

Technical Backcasting methodologies

1. An Empirical Review of Methods for Temporal Distribution and Interpolation in the National Accounts, Baoline Chen and Stephen H Andrews, Survey of Current Business, May 2008 https://apps.bea.gov/scb/pdf/2008/05%20May/0508_methods.pdf
2. Adjusting National Accounts, R. Stone, Annali di Statistica, Series IX, Volume 9, 1998
3. Review of country Practices in rebasing and linking National Accounts Series, DA-SEA-Asia , United Nations, https://unstats.un.org/unsd/DA-SEA-Asia/Documents - Lao WS/Lao WS-Country practices on rebasing and linking NA.pdf

Research papers and methods for long time series

1. A dataset on Comparative Historical National Accounts, ca 870 – 1950: A time series perspective, J.P. Smits, P.J.Woltjer and D. Ma, Groningen Growth and Development Research Centre memorandum GD-107 https://www.rug.nl/research/ggdc/data/historical-national-accounts
2. Swedish GDP 1855 – 2000: Estimates and general trends in Swedish Regional System, Kerstin Enflo, Martin Henning and Lennart Schon, Working Papers in Economic History, March 2010 https://lup.lub.lu.se/search/publication/4173872

3. Examining Ireland's Post Famine Economic Growth Performance, Tom Stark and Frank Geary, Economic Journal, Vol. 112, pp.919-935, 2002 https://papers.ssrn.com/sol3/papers.cfm?abstract_id=347125

4. Resurrecting the U.K. Historic Sector National Accounts, Bill Martin, the Review of Income and Wealth, Series 55, Number 3, September 2009. https://onlinelibrary.wiley.com/doi/10.1111/j.1475-4991.2009.00342.x/pdf