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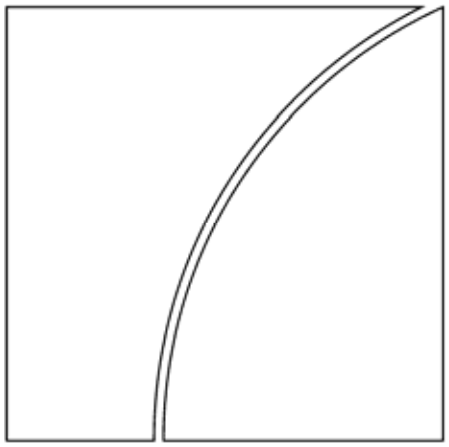

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A macro-micro approach to compiling statistics

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Abstract

This paper outlines a so-called macro-micro approach to compiling statistics that has been developed by De Nederlandsche Bank. Instead of trying to assess the plausibility of all individual micro data in all individual reports, this approach focuses first on the plausibility of a corresponding macro statistic. It has been implemented by the introduction of new statistical techniques, a set of drill-down tools (SIRIUS), in order to restrict checks of micro data to what is really relevant, and an increased comparison of macro-economic data from different sources. It is demonstrated that this way of data-analysis, applicable to any aggregate statistics based on large amounts of micro data, enables the compiler to raise both the quality of the statistics and the efficiency of the checking processes.

JEL Classification Numbers: C10, C40, C42, C81, C82, C88.

Keywords: Data quality, plausibility checks, data control, detection of outliers, drill-down tools.

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1. Introduction[1]

Statistics departments at central banks nowadays face many challenges. Users want more data, and they want it ever earlier, while the quality of the data should remain the same or even improve. At the same time, central banks aim at more efficient data collection processes and a lower administrative burden on reporting entities. All these challenges stimulate compilers to rethink existing practices to collect and analyse the data. This paper reviews recent progress made in this respect by the Statistics and Information Department of DNB.

In recent years, national and international reporting requirements have been adapted to new demands for macroeconomic statistics, such as monetary aggregates based on reports from monetary and financial institutions, and balance of payments statistics based on reports from financial and non-financial entities.[2] From the euro area perspective, for instance, the importance of these statistics – and the millions of reports underlying them – to the monetary policy of the ECB can hardly be overstated, as timely and reliable euro area series are a pre-requisite for an adequate assessment of the monetary and economic situation and future prospects. Statistics play a role everywhere, be it in monetary policy, innovations in payment systems, the monitoring of financial stability, research, or in the decision making by market players and the public at large.

In all these areas, the usefulness of statistics ultimately depends on the reliability of micro data provided by individual reporters. Yet it remains important, in particular to compilers, to realise that users are primarily interested in the reliability of *macro* figures, the plausibility of which can not and need not be guaranteed by detecting every single error in every individual statement at the *micro* level. This was one of the main ideas guiding DNB, when in 2005 it started to develop a new, so-called macro-micro approach; this approach no longer emphasises the correctness of all individual reports underlying a macroeconomic statistic, but instead starts by checking the plausibility of the macro statistics themselves. For this shift in focus, from a bottom up to a top down approach, the way had already been partially paved by the introduction, in 2003, of a system of direct, electronic reporting (e-Line) including automated checks of reported micro data. The actual shift in focus became possible in 2005/2006, when a set of powerful drill down tools, SIRIUS, was developed that helps to restrict the checks of micro data to those that really matter.

On the basis of experiences so far it seems fair to conclude that this change-over has been (very) successful. It has lead to an increase in both quality and efficiency. In particular, it has freed resources that are now partially “reinvested” in the investigation of specific problems, including those that got little or no attention in the past, but can be solved now much more efficiently thanks to the drill down feature of the tools and other features supporting the analysis (graphs, colors, signals etc).

The approach described here no doubt includes ideas and techniques already used by other compilers as well, be it only because all compilers rely on similar software to solve similar problems. National in-house experiences in this area of statistics are not yet often shared, but an increased exchange of new ideas and experiences could be fruitful and contribute to quality and efficiency. This paper aims at stimulating this process, by a description of the new way in which DNB has tried to merge the advantages of electronic reporting, statistical techniques, an economist view, graphical analysis and the full exploitation of various Excel features to deal with large numbers of micro data in a transparent way.

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[2] Other statistics concern for instance government finance statistics, financial accounts, payments statistics and international financial statistics compiled under the aegis of the BIS.

The first part of this paper looks at the *philosophy* behind the new macro-micro approach and discusses the concept of quality in statistics and the kinds of checks made at each stage of the compilation process (sections 2 and 3). How this new approach has been worked out by *tools*, and how it is actually implemented, is the subject of the second part (sections 4 to 8).[3] This part is based on the Dutch case and a *new set of tools* called SIRIUS, after the name of the department where it was introduced (Statistics and Information) and some Dutch key words in the analysis of the balance of payments statistics (BOP). Section 9 contains concluding remarks.

2. Quality in statistics: a brief overview

2.1 Accuracy and reliability

Every compilation method should ensure the quality of the statistics. However, the key question is: what do we mean by quality? Indeed, quality is an intriguing concept and most people understand intuitively what it is about. Still, it is not easy to agree upon a single definition. Statistics should portray a reasonably accurate picture of reality. If the statistics present an imprecise picture, their quality is poor. Obviously, users of statistics would like to be protected against significant imprecision.

According to the International Organization for Standardization (ISO) quality is defined as 'the totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.[4] Or to put it more simply: quality encompasses all aspects of how well statistics meet users' needs.[5] Just around the turn of the last century, there has been an upswing in the attention paid to data quality, resulting in many studies by institutions and professionals in the field. The Executive Board of the IMF, for instance, noted that it was necessary to improve the quality of the data used in policy analysis.[6] The IMF Staff addressed this call and developed a framework that would allow users and compilers to make data quality assessments. This framework – the so-called Data Quality Assessment Framework (DQAF) – is a methodology for assessing data quality by comparing country statistical practices with best practices.[7] In the DQAF framework quality refers to a concept with five dimensions – securing integrity, methodological soundness, accuracy and reliability, serviceability and accessibility – and a set of prerequisites of data quality like the legal and institutional environment. At the same time, Eurostat and the ECB have developed their concept of quality too. Their quality vectors have several dimensions in common with the IMF. Other organizations, such as Statistics Canada and Statistics Sweden use comparable sets of dimensions.

In this paper we will mainly refer to *accuracy and reliability (of initial estimates),* which are mentioned in one breath with one another in the DQAF. According to the IMF, accuracy

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[3] Although the *arrangement* and combination of building blocks and techniques reflect some tailoring to national circumstances, the building blocks and techniques themselves allow for the use in other data environments as well. The description of the tools in sections 4 to 8 will be supplemented by a description of individual building blocks (Gerrit van den Dool (2007), The use of Excel tools to assess the quality of statistics based on large numbers of reports, forthcoming)

[4] Eurostat (2003), p 2.

[5] European Commission & European Central Bank (2004), p 3.

[6] IMF (2001).

[7] IMF (2003).

pertains to the closeness between the estimated value and the (unknown) true value that statistics intend to measure.[8] Reliability relates to the closeness of the initial estimated values to the subsequent estimated values. Thus, reliability refers to revisions. The joint ECB-Eurostat Task force on Quality regards reliability as the difference between first and 'final' estimates of a statistical concept. In this respect, the reliability aspect of quality lends itself to measurement (eg the size of revision). Accuracy and reliability of initial estimates both relate to processes during the compilation of statistics; statisticians constantly need to assess the plausibility of source data from respondents. It has been observed that a certain trade-off exists between accuracy and reliability.[9] Later estimates of a concept that incorporate more information could be assumed to have increased accuracy. At the same time it diminishes the reported reliability of the earlier estimate.

2.2 Plausibility

Although not included in the DQAF, the aforementioned Task force considers *plausibility* as a significant element of the accuracy dimension. In particular, it describes the likelihood of the data which depends on, among other things, internal consistency of the data, consistency with historical data (plausibility may be assessed over time too) and consistency of the data with market conditions and trends (ie in comparison with related economic time series). On this score, unexpected sizeable outliers come to the fore and deserve the attention of the statistician. Many statistical organisations will recognise this aspect of quality while assessing the plausibility of received business reports: if statistics should capture reality, the figures should be plausible, given other information from the economy. Without doubt, all statistics organisations have incorporated some forms of plausibility checks. For instance, many institutions will rely both on automated and on manual or visual inspection of newly reported data. With the help of simple measures, such as comparing recent period-to-period growth rates, one can check whether the latest data are 'in line' with the past.

A sophisticated quality control method to identify outliers was recently provided by the Bank of Spain. This method makes use of the full information of all series, not just a few values. In essence, it automatically identifies a so-called ARIMA-model that detects and corrects for outliers. The one-period-ahead out of sample forecast is computed and compared with the new observation. When the forecast error is larger than some specified limit, the new observation is identified as an error.[10] In fact, the macro-micro approach outlined below has some features in common with this method of the Bank of Spain.

2.3 Quality versus costs/benefits

When evaluating quality – ie addressing accuracy and reliability along with plausibility – it is important to keep in mind that there exists a trade-off between the quality of the statistics and their costs and benefits. In this context, the Bank of England has developed a cost-benefit analysis of monetary and financial statistics.[11] This approach refers to the textbook model characterised by well-behaved relationships of increasing marginal costs and decreasing marginal benefits, relative to quality. Indeed, it is reasonable to assume that as data quality rises, further improvements in data quality become increasingly more costly to realise, and they provide

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[8] Carson, C S & L Laliberté (2002), p 4.

[9] European Commission & European Central Bank (2004).

[10] Maravall, A & G Caporello (2002), p 23.

[11] Bank of England (2005).

fewer additional benefits to the data users. The optimal situation would be when marginal costs and marginal benefits are equal. When applying this framework to various statistics, it becomes clear that the optimum may not always be realised. Particularly in the case of those reports with large samples or a (near) census, one may end up well beyond the optimal situation, with marginal costs exceeding marginal benefits. An example of such a statistic compiled by DNB could be the Consolidated Banking Statistics produced for the BIS that are based on a full census with a considerable degree of skewness in the distribution of almost all items reported. In these instances opportunities exist to reduce the costs for smaller reporting agents, without making too many impairments to the benefits for users of the statistics.[12]

3. Assessment and validation of the data

In the compilation process at De Nederlandsche Bank (DNB), it is important to distinguish the following three components: (1) minimum level of data quality; (2) a few dedicated plausibility checks at the micro level; and (3) further data quality checking from macro point of view (with drill-down to micro-reports).

3.1 Minimum level of data quality

There is no question that one should lay a solid foundation for the quality of the data that are to be sent by the reporting agents. By establishing minimum conditions for data quality to be imposed at the reporter's level, one is able to build on this base and to further augment the quality of data during the compilation process. DNB uses several attributes to ensure an acceptable level of data quality. *First*, it is important that the statistical obligations stemming from Regulations, Guidelines or other sources are transformed in up-to-date reporting manuals, with clear instructions for reporting agents, and are aligned with business concepts. *Second*, practice has shown that in addition to clear instructions close contacts with reporters by statisticians may be very valuable. Examples are introductory meetings for reporters in case of new reporting frameworks, installation of help-desks and also contacts on a more regular basis in order to answer questions or solve problems reporters may encounter when filling out their reports. *Third*, DNB contributes to data quality through its newly developed safe internet-based reporting tool called e-Line DNB, which includes many technical and consistency checks. This internet-based platform to collect data has been developed internally in the course of 2005 and replaced former software tools and supports various reports. The software this platform uses is generic for multiple reports. It contains many features, including, quantitative tables, qualitative questionnaires, assessment of reports, and tools for monitoring the reporting progress. As far as data assessments are concerned, e-Line DNB contains automatic technical and consistency checks that are built in the electronic reports. In principle, these checks or rules can be of a signalling or a blocking nature. Examples of a signalling rule are checks on items which are normally supposed to be equal to one another, such as total assets and total liabilities but in special circumstances could be different, eg due to rounding. In such cases, the software signals to the reporter the assumed equality making him aware that something should be checked. Blocking rules go one step further: these are meant to force the reporter to report consistently; otherwise the reports cannot be submitted to the central bank. As many reports have to be sent to DNB under a tight timeframe, reporters are forced to take immediate action. Built-in blocking rules relate

[12] See Goes (2006) where possibilities are explored for cutting-of-the tail in the Dutch report of the Consolidated Banking Statistics.

for instance to the entering of negative amounts, or to the fact that the total must be greater or equal to the sum of the 'of which' items. Similarly, reports should allow for reconciliation in a logical way (end-position should be equal to starting position taking account of transactions and valuation effects during the period). In sum, through these means an investment is made in the initial reporting of the statistics, ensuring that the data that are sent by the reporting agents are as 'clean' as possible.

3.2 Dedicated plausibility checks at the micro level

Clean data is indeed essential to any compilation process and should be verified at the point where the source data came from. As mentioned earlier, standard checking of the plausibility of every individual report is not part of the approach taken. However, before turning to the analysis at the macro level, a few dedicated plausibility checks on micro reports may be valuable and are indeed carried out by DNB.

The first case for individual plausibility checking concerns a new reporting framework. When a new framework is introduced or changes in an existing reporting framework are made, history is absent and the likelihood of reporting error is greater. On these occasions, it is necessary to inspect the plausibility of individual reports quite closely. Experience shows that reporters need to get used to new reporting forms or items. Normally, during the start-up period more errors (that go beyond consistency) are found, but these will gradually decrease in the course of time. In a similar vein, micro-inspection will be warranted when a new institution is included in the sample. Furthermore, it is recommended to check at least to some degree the plausibility of the reports of the very large reporting agents. Indeed, many questions coming from the macro-plausibility analysis (see below) as well as from the queries resulting from ad hoc statistical investigations point to the large reporters. Moreover, it is useful to carry out, from time to time, studies across all individual reporters to check whether they keep to the rules and guidelines. Individual reporters slipping through the process and and reporting consistent but incorrect data for a long time without being noticed should be avoided. By selecting reporters at random and checking their reports, they will come to understand that their reports are taken seriously, furthering their motivation to continue to comply with their reporting obligations in the future.[13] Finally, checking of individual reports is also needed in those instances when reporters are doing a bad job, and make half-hearted attempts. One may come across such problematic reporters via the aforementioned ad hoc selections, thematic research or the macro-micro analysis discussed below. In any case, they should be monitored quite closely in order to improve their reporting behaviour. In conclusion, standard plausibility checks of all individual micro-reports are not part of the data control process, but in some instances micro-inspection is valuable.

3.3 Further data quality checking from a macro point of view

After taking the steps detailed above, we turn to the macro-level analysis. Users of the data are interested in the end-product, ie the macro-statistic. It is at this level that the data are reported to (inter)national organisations and disseminated through the Internet and other publications to the public. Monetary statistics, for instance, compiled via the balance sheet items of monetary financial institutions are *macro*economic statistics and the same holds for balance of payments statistics, external investment positions, BIS statistics and so on. The plausibility of these data should be checked and assessed predominantly from an *aggregate*

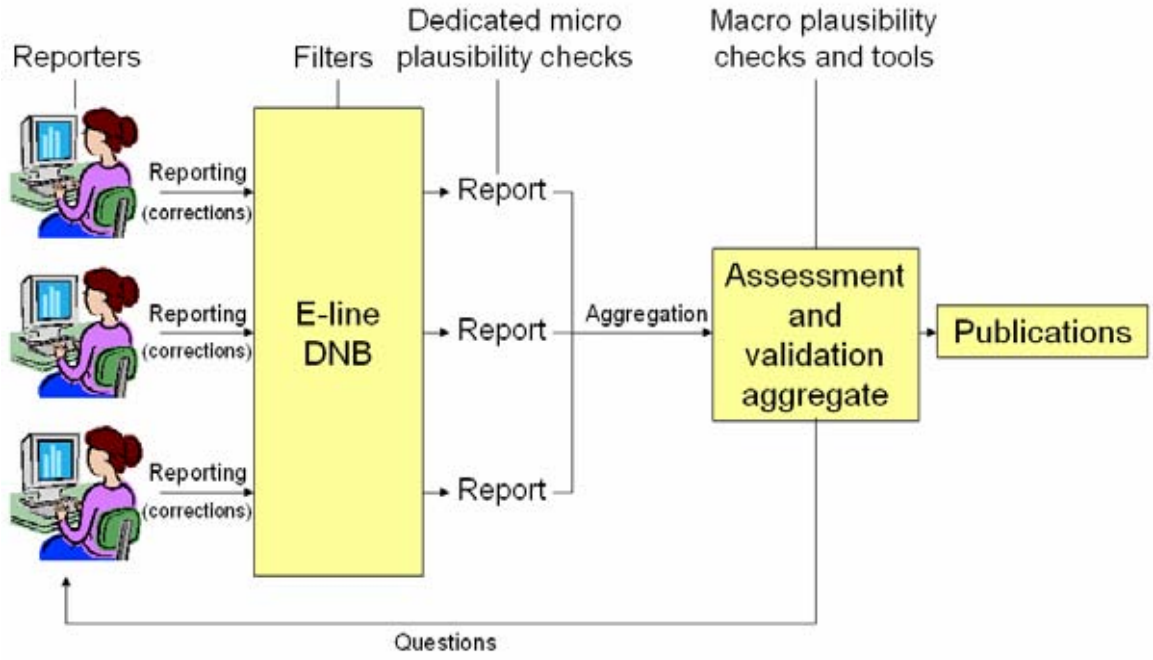
[13] In general, the motivation of reporters and the resulting quality of the statistics can also be enhanced by providing backflow of the aggregated data and discussing these with them on a regular basis.

point of view. This implies an approach that puts the emphasis on the macro-validation of the reports. Given that the minimum conditions for data quality are fulfilled, it is only when questions arise from the *macro*-level that one moves forward to the micro-level of the individual institution (drill-down). So, one works from macro to micro. Such an approach focuses on aggregate time series and growth rates.

This aggregate-led working procedure will open up opportunities for specialisation. Statisticians can focus on one or two statistics for many or all reporters, instead of concentrating on one or a few reporters for all statistics or reporting forms. Put succinctly, at DNB the approach leads to 'specialisation in statistics' and away from 'specialisation in reporting firms'. This method is expected to be both efficient as well as effective. Generally, plausibility inspection of all individual reports is time-consuming, particularly when the number of reporters is high. Moreover, a strong focus on micro-checking entails the risk that important insights resulting from the macro point of view will be overlooked. The macro-approach puts the emphasis on the coherence of the statistics at the aggregate level as an important point of reference. This coherence, on the other hand, is much more difficult to assess when concentrating on individual reports. Furthermore, a detailed analysis of each individual report may entail too many questions for reporters. From a macro-perspective these inquiries could prove redundant (eg inquiring about deposit growth when there is an increase in bank deposits all-over).

Figure 1

Macro-micro approach



A further advantage is that the aforementioned statistical specialisation is conducive to so-called *meso*analyses, where items of reports of several institutions are compared with one another. Experience shows that it is worthwhile to view reports of various reporting agents on several items (eg the contribution to mortgage lending per bank, or the share in card payments) and compare the outcomes. Our experience indicates that such efforts from a thematic angle generate more value added than close, separate plausibility checks of all individual files. The macro-micro approach at DNB is sketched in Figure 1. It will be discussed in more detail in the following sections.

4. The change-over to a top down approach and the introduction of SIRIUS – the Dutch case

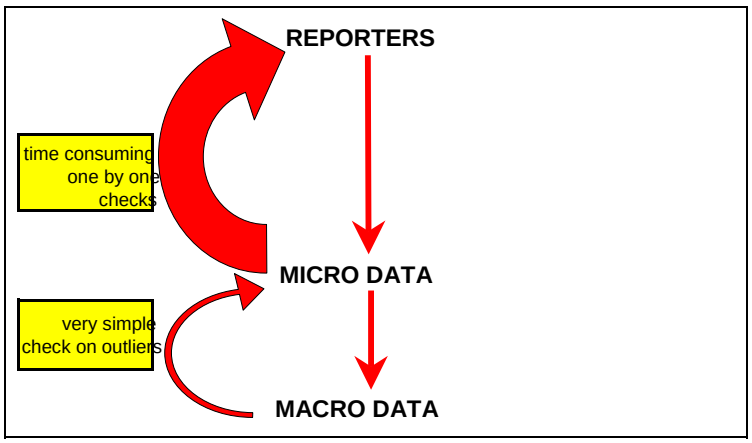
In this section, the changeover to a new macro-micro approach will be described for the BOP department of DNB. Even though the new approach applies to money and banking statistics as well, it was in the analysis of the BOP and the international investment positions (IIP) where the need for new tools was considered most urgent and the new approach has contributed most to gains in quality and efficiency.

Until 2006, the control of the quality of aggregated BOPand IIP data had mainly been bottom up, ie based on the assumption that the quality of macro estimates was best served by the control of micro data reported by individual reporters. This practice went back to the first years after World War II, when international transactions in foreign currencies were still restricted and each individual resident had to ask permits from DNB for every single transaction with a non-resident, and was obliged to report it. For almost six decades, BOP and IIP statistics were based on micro data from a settlement system and annual surveys on external positions. The quality of aggregated data was mainly established by checking individual settlement data, which was a time consuming process (Figure 1).

Over the years, this bottom up approach of quality became increasingly cumbersome due to the liberalisation of financial markets and the ensuing strong increase in the number of transactions. European integration also entailed new reporting requirements that contributed to a rising “sea” of data to be processed. In 2003, in order to keep this ever increasing inflow of individual settlement data manageable and to lower the administrative burden, the statistics division of DNB made a change-over to a new direct reporting system (in Dutch called DRA). All reporters, enterprises, pension funds, banks etc were required to *directly* report to DNB via *electronic* forms. This innovation allowed for automated checks resulting in clean input and greatly helped to improve and ensure the quality of the reported micro data. However, the level of monthly controls of micro data remained still very high. In the beginning this reflected teething troubles of DRA. Once these had been overcome, the time was ripe to shift the focus from micro to macro data. The obvious way to do so was to limit the monthly controlling efforts to big players and to check micro data only insofar as they contribute to macro problems.

Figure 2

Old situation: time consuming micro checks to guarantee sufficient quality of macro data

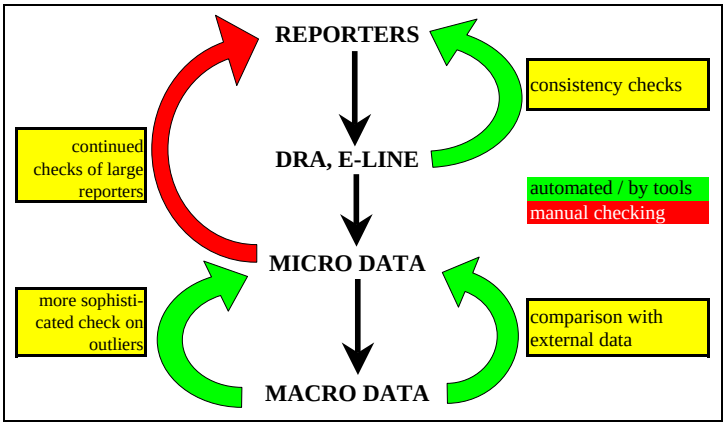


The implementation of this new approach varied across departments and statistical areas. An elaborated philosophy was evidently needed in the balance of payment department, owing to its relatively high number of monthly reporters and the consequent broad gap to be bridged between macro and micro figures. User friendly tools, to drill down from a macro problem to micro causes, were not yet available, but they were clearly a major prerequisite for the new approach to be implemented. Also, the shift in focus from micro to macro plausibility required more sophisticated statistical checks on the plausibility of macro figures.

In 2006, these issues were addressed by the development of SIRIUS, a set of new techniques and tools designed to augment the already existing consistency and other micro checks in e-Line. By the end of the year, most tools were in place or had been launched as pilots, so that resources could be reallocated. Automated micro checks and better macro checks helped to improve quality as well as efficiency and more than compensated for the reduction in time spent on manual micro checks (Figure 3).

Figure 3

New situation: automated micro checks and more macro checks



5. Overview of the three pillars of SIRIUS underlying the macro-micro approach

The new macro-micro approach has become possible thanks to the development of three pillars, three kinds of innovations, incorporated in SIRIUS, which will be discussed in more detail in the following sections.

A new statistical check on outliers at the macro level (section 6). A more sophisticated method has been developed to better identify outliers. In particular, this tool has helped to prevent wrong signals, that is, to drill down when it is not needed and to not drill down when it is.

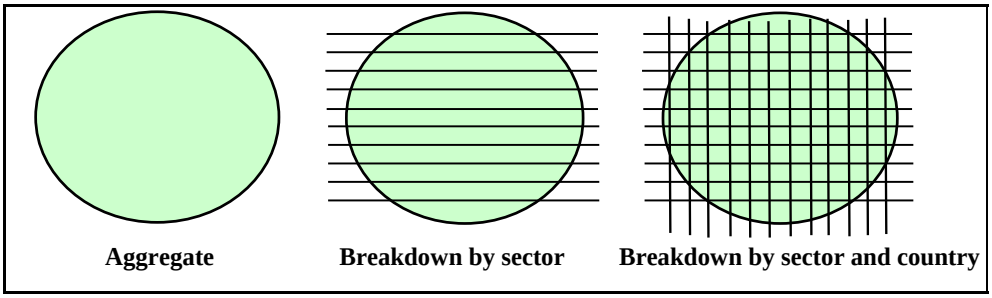
A new set of drill down tools (section 7). The new tools are all built in Excel. They allow for a more visual inspection of macro and micro data, which are now no longer only presented in tables but also in graphs. They greatly help analysts to better focus on macro problems. One of the main features of the new tools is that overview of reporters responsible for certain problems can be obtained instantaneously by just pressing a “Top 25” button. This will be illustrated for the BOP (section 7.1) and the IIP (section 7.2)

Macro economic plausibility checks (section 8). External information on exchange rates, stock market indices, and interest rate developments is now better exploited, so far mainly in the analysis of portfolio capital. An extension of this approach to other accounts of the IIP is envisaged.

Thanks to the high speed of the drill down tools, the use of pivot tables, and special *zapping buttons* in Excel, it has not only become possible to check aggregates in an efficient way, but also to quickly scan breakdowns, eg by sector, by groups of countries and by other dimensions such as the origin of the data (reported, grossed up, external sources, imputation and so on). This so-called multi-grid approach has helped to limit the chance of overlooking outliers that could offset each other if they are in the same "slice" of data (Figure 4).

Figure 4

Analysis of aggregates by a multi grid approach



Dispersion measures, such as bar diagrams of reported amounts, are also considered as additional instruments to discover offsetting outliers.

6. A new statistical technique to check aggregated data on outliers (first pillar)

As indicated above, the quality of BOP data can be controlled by a top down approach once minimum quality of micro data is guaranteed and provided reliable tools are available to determine which macro figures are worth further investigation. At the start of DRA, the first condition was fulfilled by several consistency and completeness checks in e-Line DNB. However, as for the check on outliers in the balance of payments, there was room for some improvement, in particular in the definition of outliers. An aggregated figure in the BOP of month T_i used to be called an outlier if it deviated by more than two standard deviations from its average over the period T-1 to T-12 . The limitations of this definition were well known. For instance, the possibility of detecting an outlier could be hampered by large preceding outliers, in the same way as an eye can be blinded temporarily by a strong flash of light.[14] Moreover, the definition assumed a horizontal trend, relative to which outliers were measured, whereas the actual short term trend could be rising or falling.

[14] An outlier in month T-5, for instance, would feed into the 12 month standard deviation and thus inflate the "confidence interval" over the period T-5 to T+6, making it less likely that data would lay outside the interval over this period.

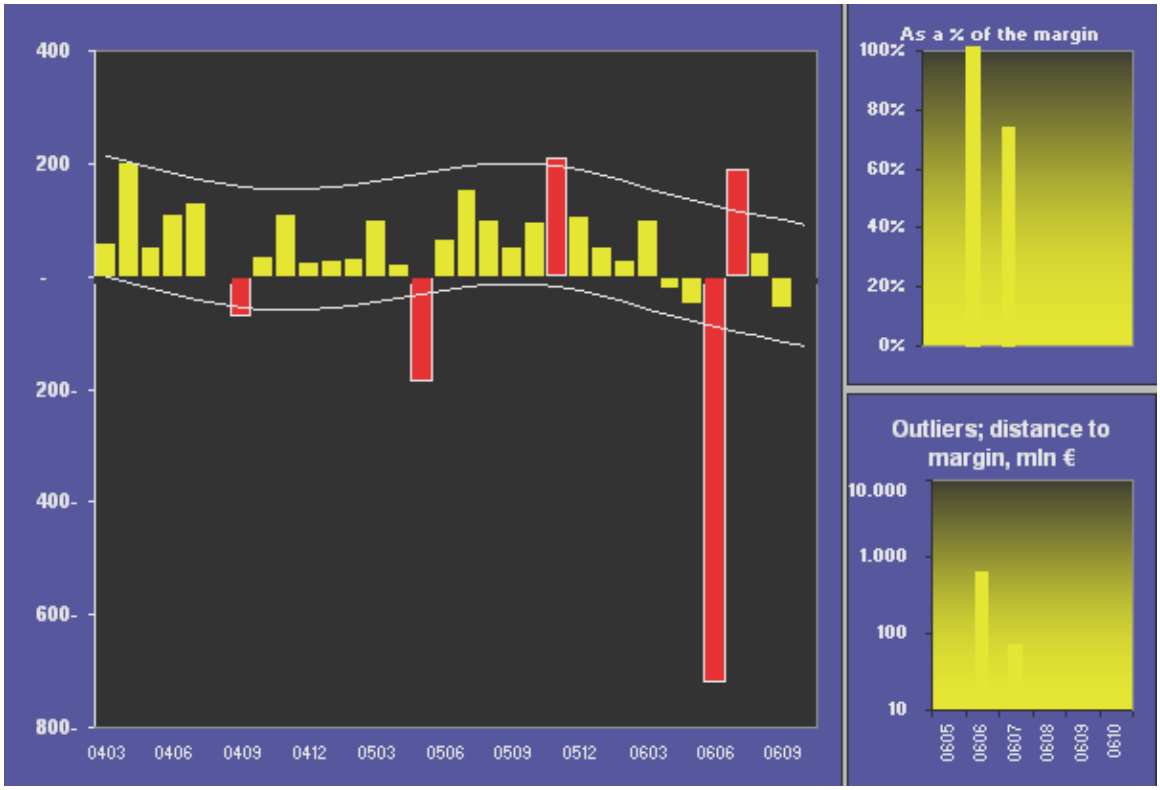
A new indicator has therefore been developed that corrects for distorting large outliers. Outliers are now defined relative to a flexible trend over a period of about 36 months. The indicator is now used to identify outliers not only in the most recent reporting month but also in previous months, which could produce fresh outliers due to revisions of the figures. A basic feature of the new technique is the estimation of a more realistic short term trend that is used in the checking processes and in the economic analysis of the data. This trend is estimated by means of a Hodrick Prescott (HP) filter. Other statistical techniques (Kalman filter, ARIMA models) have been considered as well, but so far the HP-approach has worked satisfactorily. The identification of outliers, which consists of a number of iterative steps, is described in Annex 1.

It goes without saying that the delineation of outliers is always somewhat arbitrary. Additional iterations would result in ever smaller outliers that may not be worth special attention anymore. Also, it should be noted that high or low figures may just reflect seasonal factors, as is the case, for instance, for payments of dividends. Outliers should therefore be interpreted with "judgement". They do not always automatically deserve special investigation.

In order to avoid a mechanical approach, the new identification technique has been supplemented by special graphs, allowing for a quick visual inspection of longer time series, including seasonal patterns. Colour signals and other indicators have been added to assess the need for a drill-down of the data (Figure 5). The Excel tools also contain tables with quantitative data on outliers, such as their distance to the confidence interval, both in euros and as a percentage of the interval (the same data as shown, for the last six months, in the right-hand panels of Figure 5).

Figure 5

Outliers in an aggregate series of FDI [15]



[15] The small charts are included to encourage analysts to only inspect outliers that are clearly visible despite the "yellow fog".

7. New drill down tools to implement the macro-micro approach (second pillar)

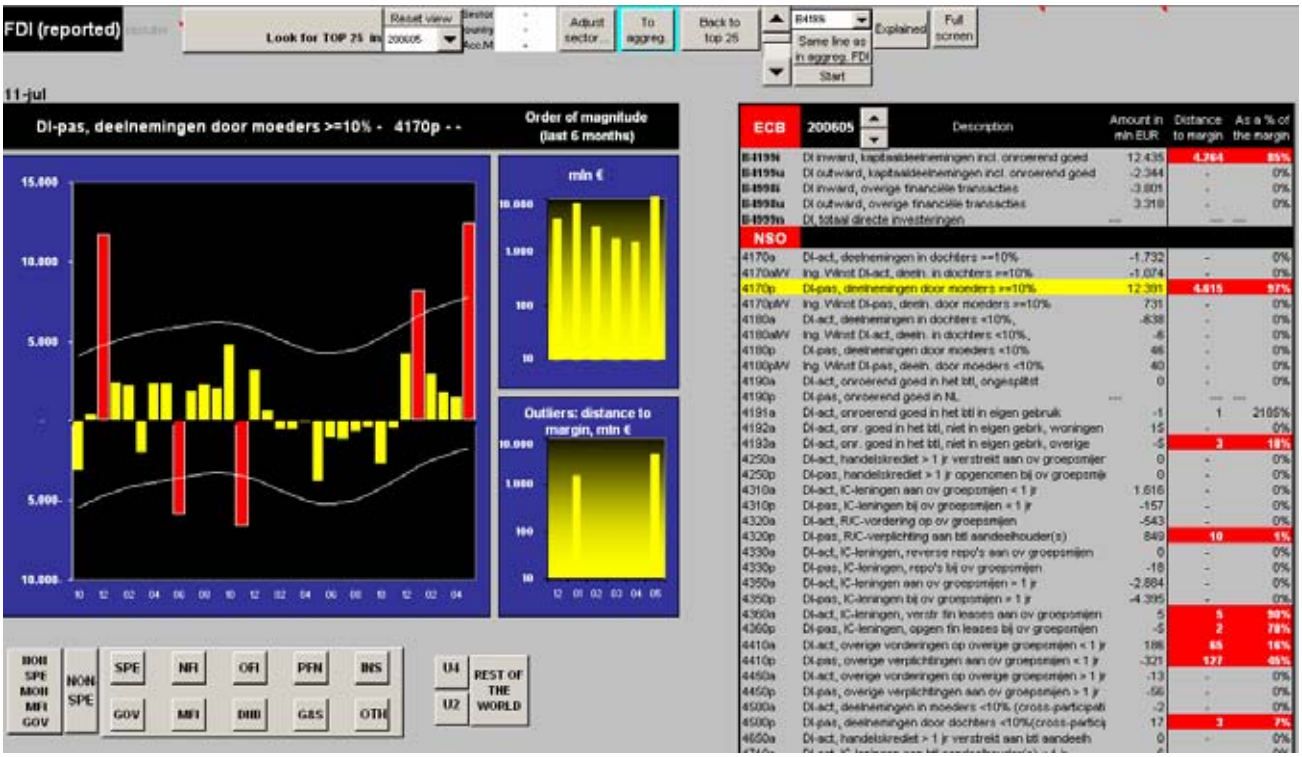
As explained above, in case of large numbers of reporters and transactions, a top down approach requires powerful drill down tools. The new tools developed in 2006 do indeed help to focus on what matters, from a macro perspective, and to go from macro to micro in an easy and user friendly way.

High speed drill-down tools have been introduced for the monthly analysis of flows and for the integrated, quarterly analysis of flows and stocks (and their revisions).[16] Most tools consists of three sheets: 1) a macro sheet including grossed up data and manual corrections on macro data, 2) a sheet consisting of aggregates based solely on reported micro data and, 3) a top-25 sheet. The second sheet, shown in Figure 6, is usually taken as the starting point for drilling down exercises to explain outliers caused by individual reporters.

Drilling down consists of scrolling to an item (the right hand side in Figure 6), selecting a specific month and pressing the special drill down button (upper left side). The (instantaneous) result is a table and/or a graph of the 25 main reporters for this item (Figure 7). All retrieving and sorting procedures have been automated by Visual Basic programmes. The (nightly) downloading of macro and micro data into the Excel tools has also been automated. The drill down tools for transactions and positions are further discussed in sections 7.1 and 7.2.

Figure 6

The aggregated data sheet on FDI (May 2006)



[16] Stocks are published only once a quarter.

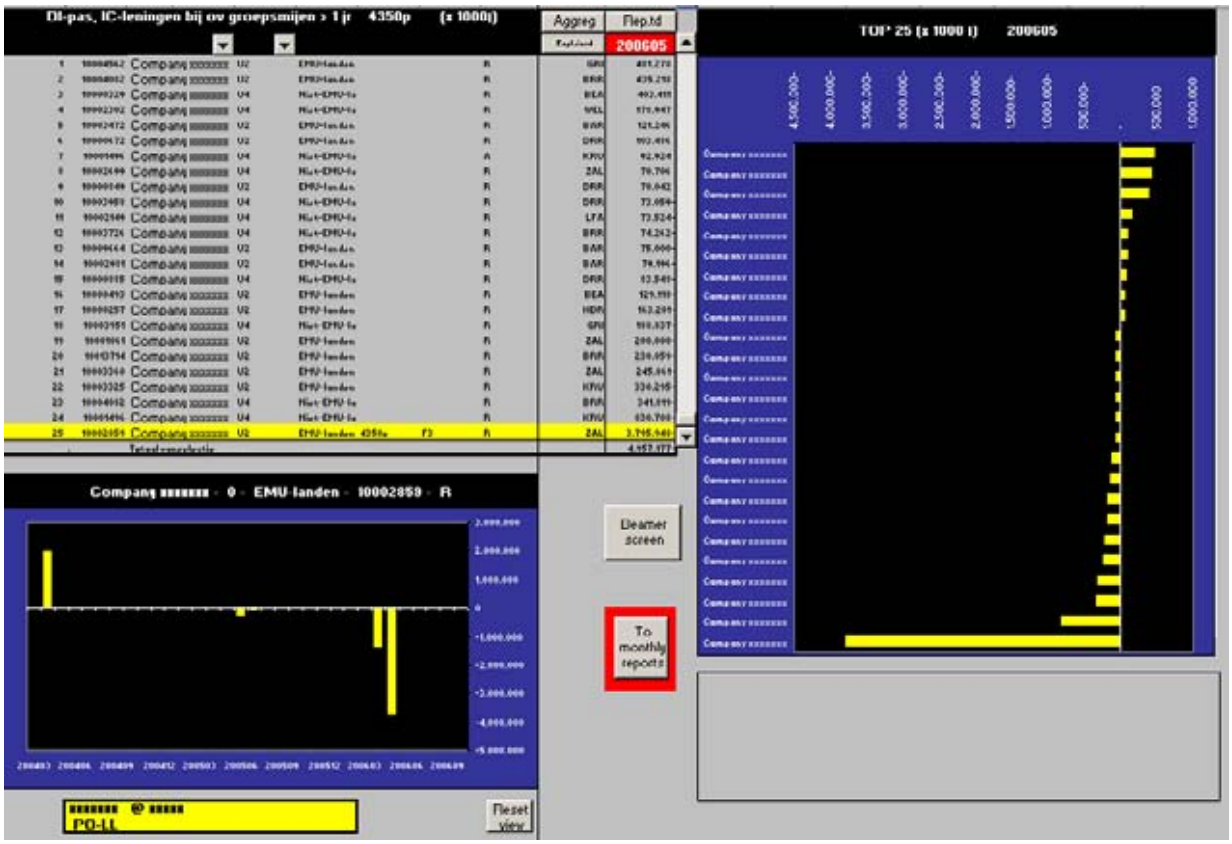
7.1 Quality control of monthly BOP figures (pillar 2a)

The analysis of monthly BOP data is supported by graphs and tables that cover a 32-month period, which is considered sufficiently long to serve different purposes (mainly to check for outliers in the reporting month and (for revision rounds) older months as well). Given the large number of reporters and items in BOP, the number of elements to be processed is correspondingly large. The number of records exceeds by far the maximum number of rows in Excel 2003 sheets.

Hence, separate versions of the drill down tool have been made for different components of the BOP.[17] Figure 7 gives an example of the outcome of a drill down exercise. Figures 5 and 6 are further clarified in Box 1 at the end of this section.

Figure 7

Example of a drill-down result: the top 25 sheet[18]



[17] The components are: 1) the current account (items reported to DNB include mainly income and some services), 2) direct investment (FDI), 3) portfolio capital, 4) other capital. All tools contain a sheet similar to the one shown in Figure 6 for the analysis of FDI. A special tool has also been constructed to check the balance of inflows and outflows reported by SPEs (see Annex 2, which also illustrates the use of a top down ("fishbone") approach to outliers.

[18] For confidentiality reasons the names of individual reporters have been masked.

The new tools allow for a multi-grid approach to avoid the overlooking offsetting outliers. This problem has been limited by the inclusion of "zapping" buttons that allow a quick scan of data from different angles, such as sectors and country-sector combinations. These scans have become common practice since the recent reorganisation of the Statistics and Information Division, in which the new departments more closely correspond with specific sectors. Even so, it may happen that a reported amount fails to be recognised as an outlier because it is *small* compared to its normally much *higher* level. Such an outlier, possibly even *zero*, would not show up in a top-25 ranking of high positive and high negative, that is *non-zero* amounts. Although this type of outliers is much less common, it was considered worthwhile to also have a tool that deals with suspiciously *small* amounts. It is described in Annex 3.

Box 1

Main features of the tool to analyse outliers in the monthly BOP

– In Figure 6, the table to the right shows for a specific month, May 2006, the aggregates of data that have been reported by individual reporters on components of the FDI account. Other months can be selected, during a revision round for instance, by the button in the top of the table. The table distinguishes between items reported to the ECB and to Statistics Netherlands.

– In the table, a component of FDI such as equity capital can be selected (and will then be marked yellow) by the scrolling button above the table. The 32-months history of the selected BOP item is shown in the graph to the left.

– Outliers at the aggregate level are marked red, both in the table and in the graph. The table includes the distance of outliers to the margin, both in euros and as a percentage of the confidence interval, so that analysts can investigate large outliers first.

– The monthly checking of data consists of scrolling through the table and assessing the outliers in the graph. Inspections can be refined by clicking the bottom left buttons for sectors and country-groups (euro area / non-euro area).

– Drilling down, to inspect a suspicious outlier in a specific month, consist of pressing the top-25 button. The top-25 sheet (Figure 7) appears on the screen. It shows which reporters contribute most to the selected outlier. The amounts are ranked top-down in the table and in the corresponding graph. The table provides information on reporters and their transactions.

– The right hand graph in Figure 7 is included to more easily determine if an outlier is mainly caused, as in Figure 7, by just one reporter (that could point at an error) or by several reporters (which is more likely to point at a common cause, not necessarily an error).

– If a reporter contributes to an outlier, ie if it is part op the top-25, it cannot be concluded beforehand that this contribution deserves a special clarification, as the reported amount need not be exceptional compared with amounts previously reported by this reporter. Also, a high inflow may just reflect the repayment of a high loan provided to a non-resident in a previous month. Therefore a special graph (Figure 7, bottom left) has been included to assess the "contact-worthiness" of an outlier. In this graph a reporter can be selected by scrolling to the reporter in the table (marked yellow). Within the top-25 a further restriction, for instance to SPEs, is possible by means of filters.[19]

[19] To assess a transaction in relation to other transactions of the same reporter, a hyperlink is included (red square) to a file with all transactions recorded for the month under investigation (this possibility is limited to the most recent month).

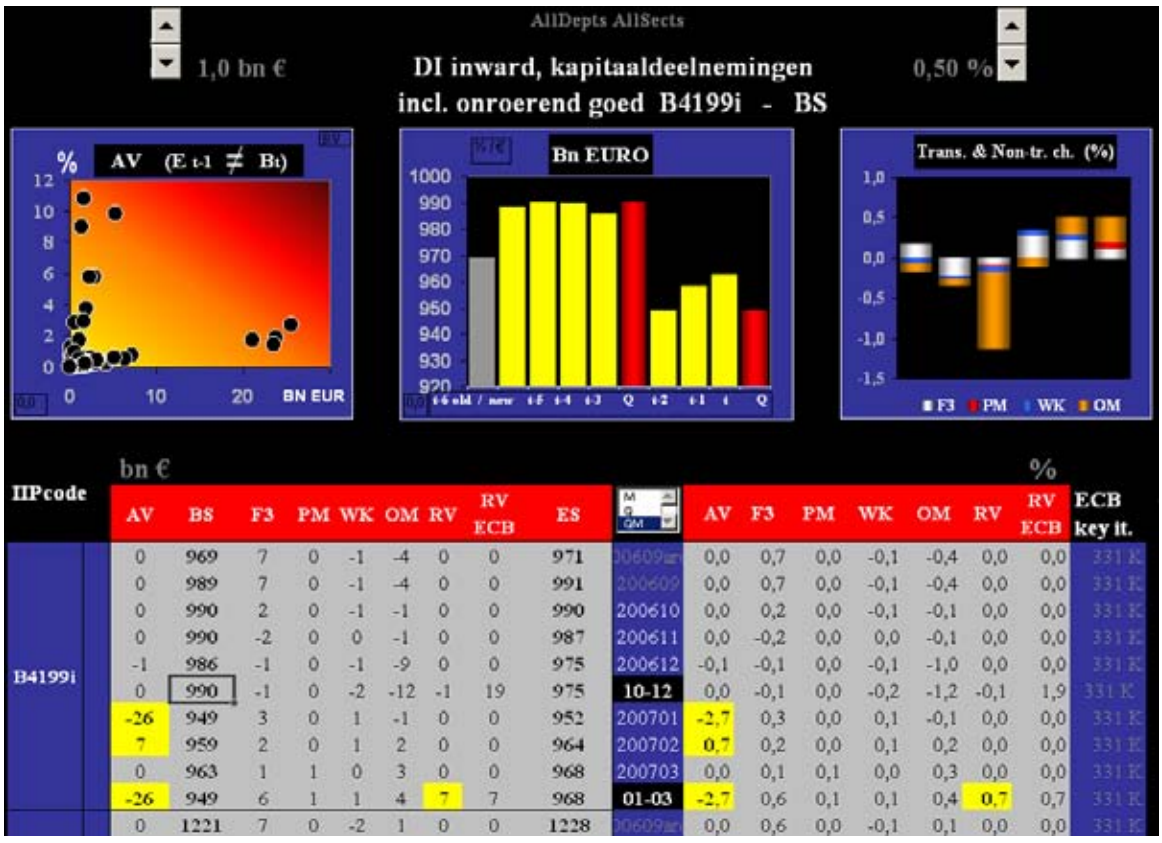
7.2 Quality control of the IIP and its revisions (pillar 2b)

The international investment position is reported to international institutions and published in quarterly bulletins, on a quarterly basis. The analysis usually covers a period of two quarters for which revised figures on stocks (and flows) are reported as well. In view of the relationship between stocks and flows, a tool has been made that integrates different checks on flows and stocks and their revisions. It actually consists of two sub-tools, one for the analysis of the reconciliation and the other for the analysis of revisions. Pilots of the tools have been used since the second half of 2006. The follow-up versions to be implemented later this year is discussed below.

The reconciliation tool, a sub-tool to reconcile transactions, positions and non-transaction changes, consists of three sheets.[20] The macro-sheet is shown in Figure 8. Each line in the grey block includes for a specific IIP code, for a specific period, all items that play a role in the *reconciliation*, such as positions at the beginning of the period (BS), changes in positions due to changes in prices (PM), flows (F3) etc. If a line contains an inconsistency above a certain threshold, say 1.5 billion euro and/or 0.25 per cent of a position, this is indicated by a yellow colour signal. An overview of all inconsistencies is also given by the dots in the left hand chart in Figure 8.

Figure 8

Checking reconciliation in the IIP



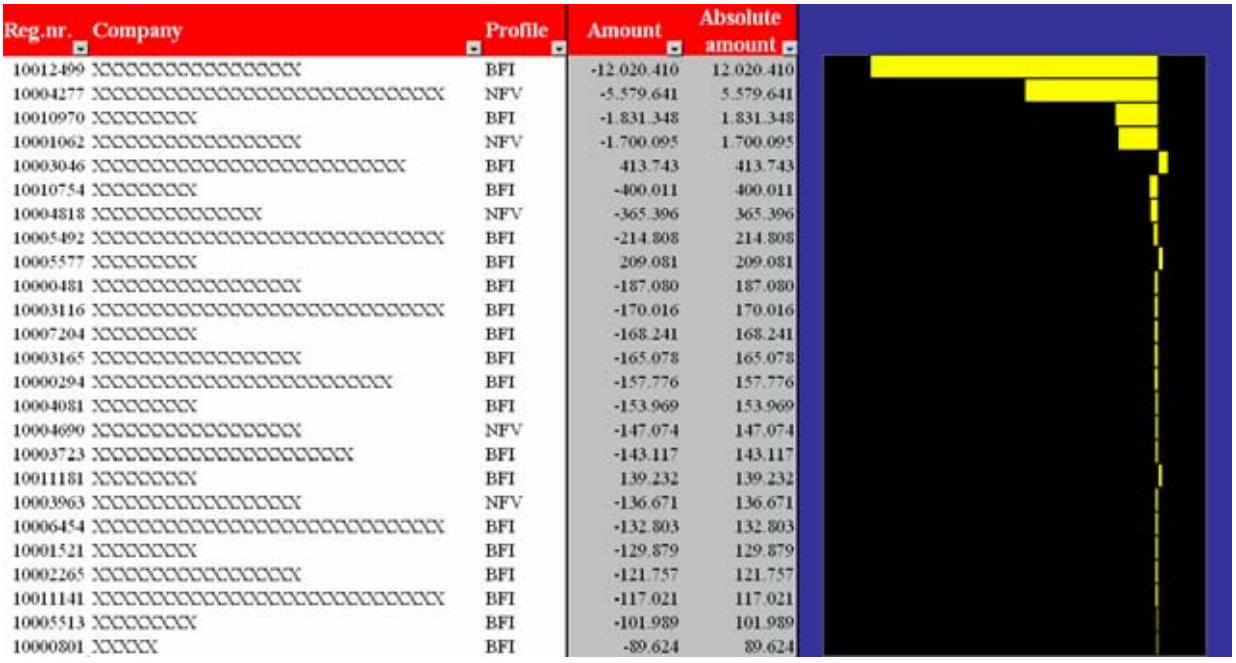
[20] Unlike the tool to analyse flows, it covers only six months plus an additional month (t-6, to check if its end positions equal the opening positions in month t-5).

The analysis first focuses on period-to-period and on within-period inconsistencies (in Dutch: AVs and RVs). Both are shown in terms of euros and as a percentage of the corresponding positions to allow for a quick overview of all the problems to be analysed. The chart in the middle supports a visual detection of other issues worth further scrutiny. The right hand chart gives a breakdown of changes in positions over six months.

As the aggregated data in the macro sheet may cover hundreds or thousand of rows, the sheet includes different filters (not shown here) to limit controlling efforts to what really matters, ie the problems above the threshold (which can be lowered during subsequent rounds). Once large problems are selected, their causes at the micro level can be easily brought to the surface by double-clicking the corresponding cells in the left grey data block. A double-click on an amount in the macro sheet results in an overview of the top-25 contributors at the micro level (eg in Figure 9 to check the minus 26 billion euro in January 2007).

Figure 9

Top-25, micro result of double-clicking on an inconsistency in the macro sheet



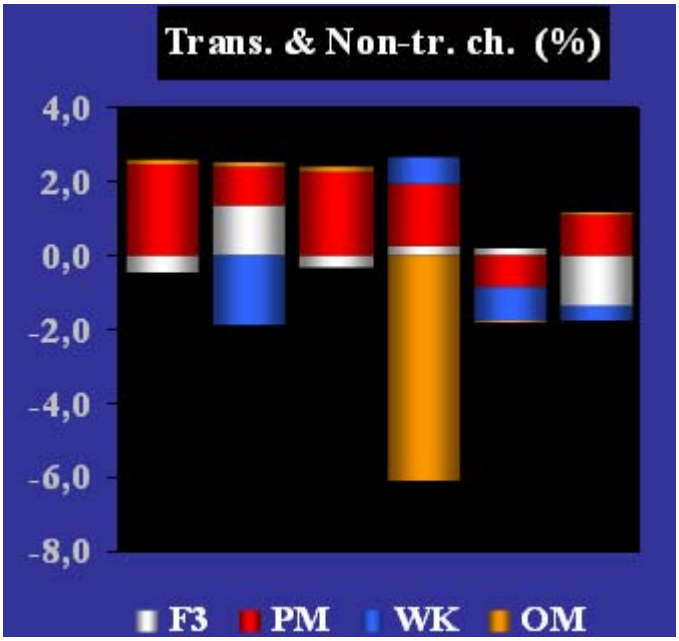
Reg.nr.	Company	Profile	Amount	Absolute amount
10012499	XXXXXXXXXXXXXXXXX	BFI	-12.020.410	12.020.410
10004277	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	NFV	-5.579.641	5.579.641
10010970	XXXXXXXXX	BFI	-1.831.348	1.831.348
10001062	XXXXXXXXXXXXXXXXXX	NFV	-1.700.095	1.700.095
10003046	XXXXXXXXXXXXXXXXXXXXXXXXXXXX	BFI	413.743	413.743
10010754	XXXXXXXXX	BFI	-400.011	400.011
10004818	XXXXXXXXXXXXXX	NFV	-365.396	365.396
10005492	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	BFI	-214.808	214.808
10005577	XXXXXXXXX	BFI	209.081	209.081
10000481	XXXXXXXXXXXXXXXXXX	BFI	-187.080	187.080
10003116	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	BFI	-170.016	170.016
10007204	XXXXXXXXX	BFI	-168.241	168.241
10003165	XXXXXXXXXXXXXXXXXX	BFI	-165.078	165.078
10000294	XXXXXXXXXXXXXXXXXXXXXXXXXX	BFI	-157.776	157.776
10004081	XXXXXXXXX	BFI	-153.969	153.969
10004690	XXXXXXXXXXXXXXXXX	NFV	-147.074	147.074
10003723	XXXXXXXXXXXXXXXXXXXXXX	BFI	-143.117	143.117
10011181	XXXXXXXXX	BFI	139.232	139.232
10003963	XXXXXXXXXXXXXXXXX	NFV	-136.671	136.671
10006454	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	BFI	-132.803	132.803
10001521	XXXXXXXXX	BFI	-129.879	129.879
10002265	XXXXXXXXXXXXXXXXX	BFI	-121.757	121.757
10011141	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	BFI	-117.021	117.021
10005513	XXXXXXXXX	BFI	-101.989	101.989
10000801	XXXXX	BFI	-89.624	89.624

After the checks on inconsistencies follows an inspection of the changes in positions due to changes in exchange rates or stock market prices or other changes. To that end, the macro sheet includes a graph to inspect these non-transactional changes, shown as a percentage of positions, and to compare them with each other and with the transactions that have been reported (Figure 9). Although thresholds have not yet been established to detect suspicious amounts, the double-click possibility is available to go straight from a high amount or percentage in the table (the grey data blocks) to the individual reporters responsible for it.

Figure 10 shows as an example of transactions and non-transactional changes in the foreign equity position of the Netherlands over a period of six months. The contribution of other changes (OM) seems to be rather high, compared to changes caused in the foreign exchange markets and the stock markets. It could, therefore, deserve a closer look and contacts with some reporters. Drilling down helps to determine if this is really needed. Some other features that facilitate the analysis of reconciliation are described in Box 2.

Figure 10

Breakdown of the total change in a component of the IIP



Finally, large revisions too should not go unnoticed and deserve an explanation, internally and to international institutions to which they are reported. Therefore another important sub-tool for the quarterly analysis focuses on revisions of flows and ensuing changes in stocks. For each item in the BOP, revisions of flows above a certain threshold are checked (in the updated version of this subtool, to be implemented in 2008, the threshold will depend on the standard deviation of the item over the past 32 months).

This check works in the same way as the sub-tool for the analysis of reconciliation (Figure 12). For a given IIP item and a given period the change in the end-of-period position (ES) is broken down into the underlying changes (indicated by Δ's): changes in opening positions (BS), revisions in reported flows (F3, partly due to updates on the basis of annual reports, including for instance, of which item, "retained earnings") and revaluations (HW). To get the top-25 contributors, here too it suffices to double-click a yellow cell (that one could chose to make sensitive to very small revisions).

Figure 12

Checks on revisions

ARC	BS	Δ	F3	Δ	VV	INK	Δ	HW	Δ	ES	Δ	Period	F3-new	ES-new
	0	0	0	0	0	0	0	0	0	0	0	jan	0	0
	0	0	0	0	0	0	0	0	0	0	0	feb	0	0
	0	0	0	0	0	0	0	0	0	0	0	mrt	0	0
	0	0	0	0	0	0	0	0	0	0	0	apr	0	0
	0	0	0	0	0	0	0	0	0	0	0	mei	0	0

Box 2

Some special features of the tool to analyse the reconciliation of flows and positions

– As illustrated by Figure 8, thresholds can be defined in terms of euros and percentages. They may be set at a higher or lower level, depending on the immediate work load, for instance. The number of "signal lights" and dots in the charts may be adjusted accordingly. At a high work load, smaller amounts could be checked and possibly corrected at a later stage, even after the publication of the figures and their reporting to international institutions.

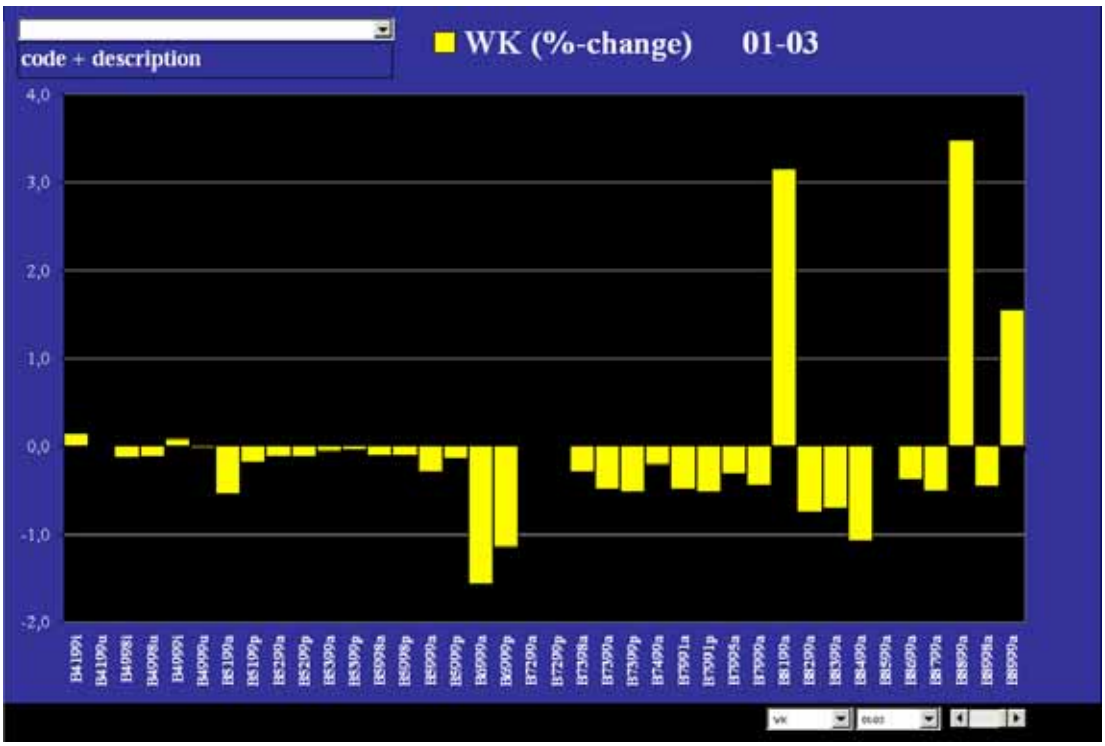
– The multi-grid approach is applicable here as well. The data to be analysed can be restricted to the non-euro area, for instance, to a specific sector or department, in line with the new organisational structure of the Statistics Division.

– The number of signals can sometimes be rather high. In order to avoid confusion, special buttons have been included in the macro sheet to support a structured walk-through, so that none of the problems to be checked is missed. Special buttons facilitate the exchange of information during meetings. Also the transfer of explanations from templates filled out by individual departments to division wide macro sheets has been automated. During the quality assessment process the progress made is indicated by a pie chart of the explained and unexplained amounts.

– Another important feature of the reconciliation tool is the possibility to get for all IIP codes an overview of large changes in positions due to changes in prices (PM), exchange rates (WK) and other changes (OM). These too can be inspected by charts that are accessible by one mouse click in the macro sheet (Figure 11).

Figure 11

An overview of non-transactional changes in all main components of the IIP[1])



[1] The figure shows changes in positions due to changes in exchange rates (Dutch: wisselkoers, German: Wechselkurse)

8. Plausibility checks of macro figures by the use of other macro-economic information (third pillar)

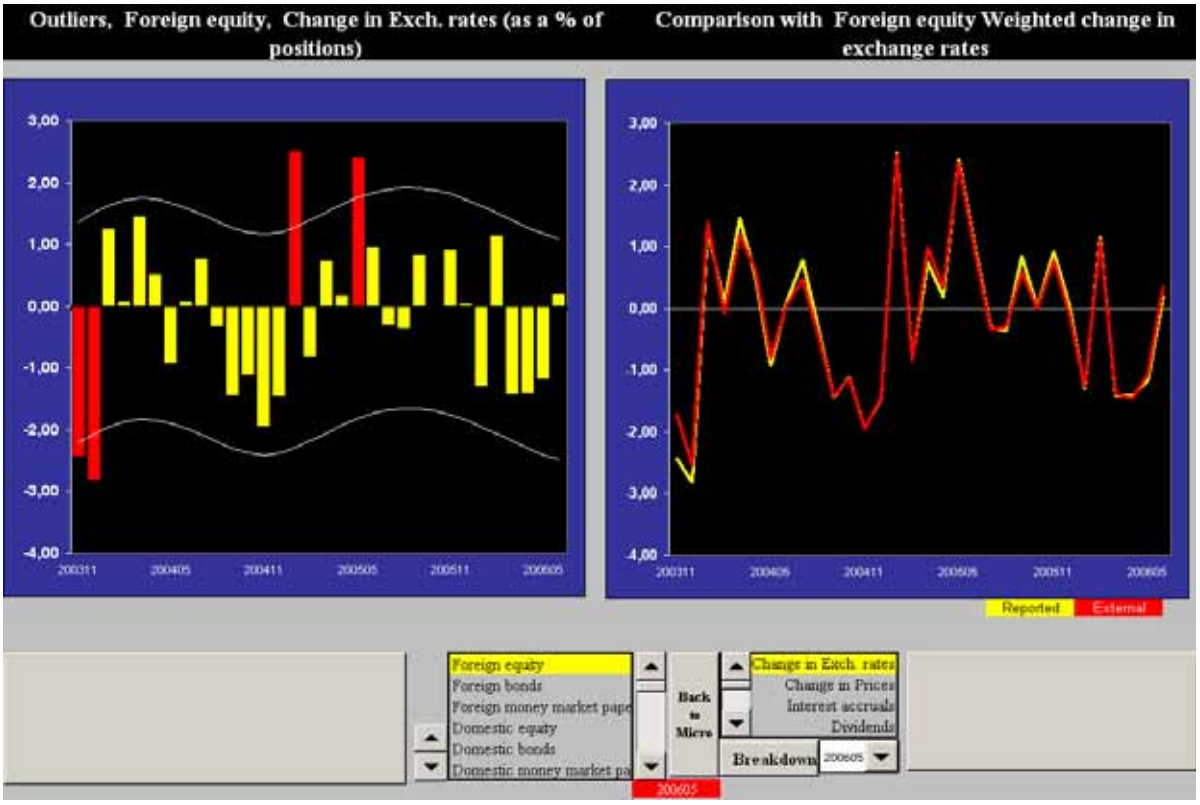
In addition to a new technique to identify outliers (first pillar) and a set of new tools (second pillar), the third pillar under the top down approach is the increased use of macro-economic data to check the plausibility of BOP and IIP data. The new drill down techniques also incorporate a new tool for the analysis of changes in positions due to changes in exchange rates, stock market indices, interest rate accruals and the payment of dividends. Aggregates of *reported* micro data are now more systematically compared with *calculated* data, such as (weighted) exchange rates, the Dow Jones index and euribor.

The new tool is to be implemented in the second half of 2007, first for portfolio capital and, later on and, to the extent possible, for other components of the BOP and the IIP. A more systematic comparison of trends in the data with those observed by international organisations has been put on the research agenda. A major source in this respect is the overview of "International banking and financial market developments" published by the BIS. Likewise, it will be investigated if foreign direct investment can be made subject to deeper analysis by looking into various dimensions such as country, industry and the nature of ownership, and comparing trends in national FDI figures with those in the quarterly "International Investment Perspectives" of the OECD.

The sheet containing the checks on the plausibility of *aggregates* in protfolio capital is shown below (Figure 13).

Figure 13

Comparison of aggregated reported data with external macro-economic data

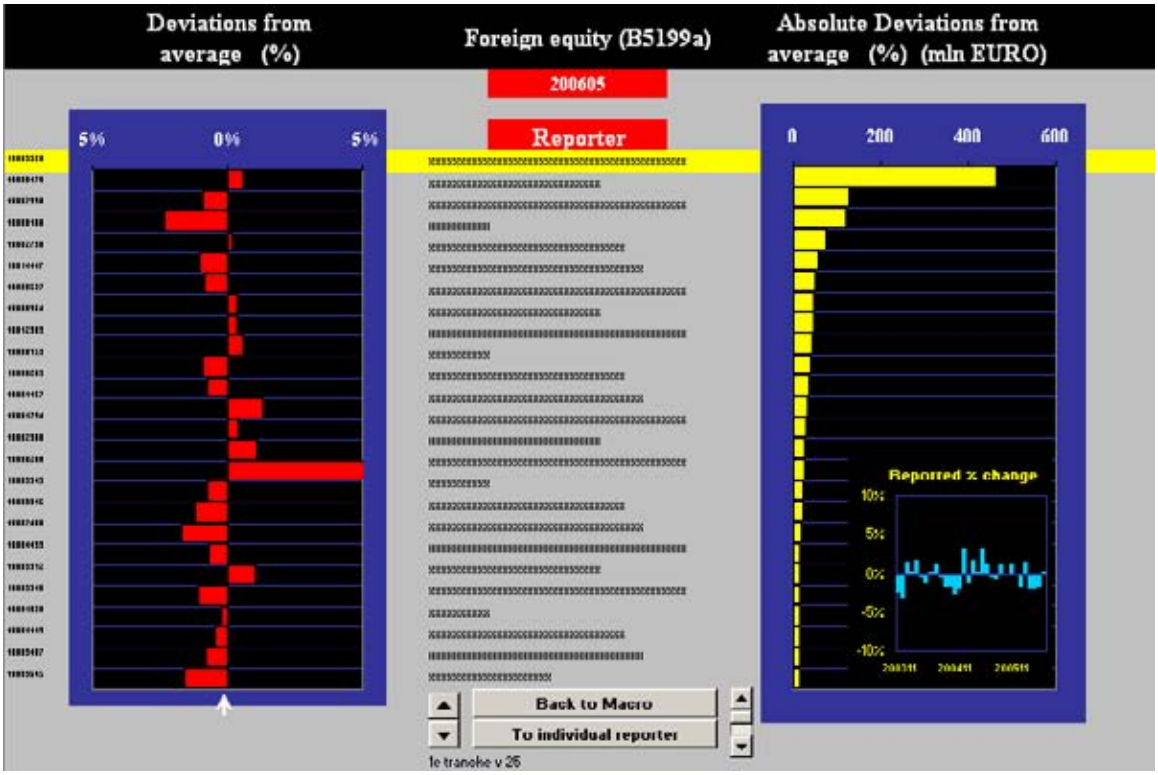


The left hand panel shows how much the *reported* foreign equity position of the Netherlands has changed over the latest 32 months due to changes in exchange rates. The right hand panel compares this change (now represented by a yellow line) with the change that can be *calculated* from beginning positions and external foreign exchange data (red line). In this example, the difference between the two lines happens to be negligible, reflecting the high quality of the reported data, but similar checks for other changes (in prices, dividends paid, interest accruals) and other instruments (bonds and money market paper) sometimes do show divergences worth further investigation.

When the reported and external/calculated figures differ, the reporters responsible for the difference can be found by pressing the button “Breakdown”, which instantaneously gives the differences between the reported amounts and the calculated amounts derived from the external data (Figure 14).

Figure 14

Breakdown of changes in the foreign equity position due to changes in exchange rates



The right hand graph shows the 25 reporters with the largest deviations from average, translated into euros and ranked top down. In the left hand graph these deviations are expressed as a percentage of the positions of the individual reporters. Even absent any outliers at the macro level (and the need to drill down), this graph can be useful anyway to find outliers at the micro level (see the positive outlier exceeding –5 per cent in the left hand panel of Figure 14). Whether a reporter needs to be contacted or not also depends on what he has reported in the past (*cf.* the use of reporting histories in Section 6). This can be checked in the small graph at the bottom right, which shows the history of the first reporter and, at least in this example, indicates that in terms of percentage points the deviation is not unusually high. The reporting histories of other reporters too can be inspected by further

scrolling down (the highlighted part then shifts down as well). For a selected reporter a sheet with more detailed information on its *position* - the denominator of a possibly suspicious percentage, that could therefore also be worth an inspection - can be obtained by pressing another button (“To individual reporter”).

9. Conclusions

Producing macroeconomic statistics of high quality in an efficient way is one of the main challenges compilers are facing nowadays in view of the continuously “rising sea” of data and the need to limit the administrative burden on reporters. The new macro-micro approach developed at De Nederlandsche Bank aims at raising both quality and efficiency. The new way of analysing the data implies a shift in emphasis from micro to macro figures and is applicable in all statistical areas. It is suited in particular for the analysis of huge amounts of reported data, as is the case in many countries for the BOP and the IIP statistics. One of the factors that greatly contributed to the possibility of the new approach was the introduction by DNB (in 2003) of e-Line, an electronic reporting system that, in combination with a limited number of dedicated micro-checks, guarantees a minimum level of data quality at the micro level (clean data). However, the actual implementation of the new top down philosophy required also three other pillars, which became available in 2006: a new sufficiently reliable statistical technique to identify outliers; a set of drill down tools, called SIRIUS; and finally an increased use of external data to check macro-economic plausibility.

Thanks to SIRIUS analysts can now, in a much more efficient and precise way, distinguish between amounts that deserve further investigation and those that do not. As a result, the number of checks and phone calls and e-mails to reporters has decreased substantially, even though the new tools have also drawn attention to issues that went unnoticed in the past. Thanks to a better identification of outliers, both by statistical methods, visual inspections and the use of external macro-economic data, the quality of the data at the aggregated level has also significantly improved. A quantification of the progress already made so far would not be easy, as a comparison would require the use of the old and the new approach in parallel. However, based upon our experience over the past one year and a half, it seems safe to say that quality and efficiency can be *both* enhanced by an appropriate set of Excel tools. More emphasis on one objective need not go at the expense of the other, but may even support the other objective. It appears that sometimes it *is* possible to have your cake and eat it, at least in the world of statistics.

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Annexes

Annex 1
The determination of outliers

Outliers in time series of BOP items are determined in a number of steps as described below. The procedure has been automated in Excel.

First, the series to be analysed, ending in, say, month T, is extended to month T+4 by projections. Projections are a weighted average of extrapolations of the actual and horizontal trends (linear trends) over the period T-1 to T-12. The purpose of this extension is to allow the calculation of the trend in month T as a *centred* average. This extension is quite common before the application of the HP filter, which implies to the calculation of trends as *centred* moving averages. The extension does not, of course, solve the well known problem that more reliable identification of "the" trend and outliers in a current period can only be made in the future.

For each month, a trend value is estimated by means of the HP filter (which has been translated into Excel). The deviations from trend - the differences between actual and trend values - depend on the flexibility of the trend, which in turn depends on a parameter, lambda. Lambda has been fixed at 100.[21]

Most deviations from trend lie within a certain range, a "confidence interval", which for normally distributed data, for instance, could be four times the standard deviation of the distribution (the 95 per cent interval). A similar interval is calculated here as well, even though deviations from trend may not (always) be normally distributed. However, to prevent the interval from being inflated – and the indicator being temporarily blinded – by some very significat outliers, it is narrowed by correcting for high outliers. This is done in the iterative procedure described in the next step.

The confidence interval is used to identify outliers. First, the most significant one, as measured by its distance to the trend, is selected. To neutralise its impact on the interval itself the outlier is made equal to the average of its four "neighbours" (two to the right, two to the left; near the endpoints the average is based on three or two instead of four neighbours).

As a series of 32 months may well include more than one exceptional outlier with an inflationary effect, steps 1 to 4 are repeated three times. Each round results in a less disturbed trend and a less inflated interval, that get increasingly sensitive to the more "normal" outliers that one would like to detect.

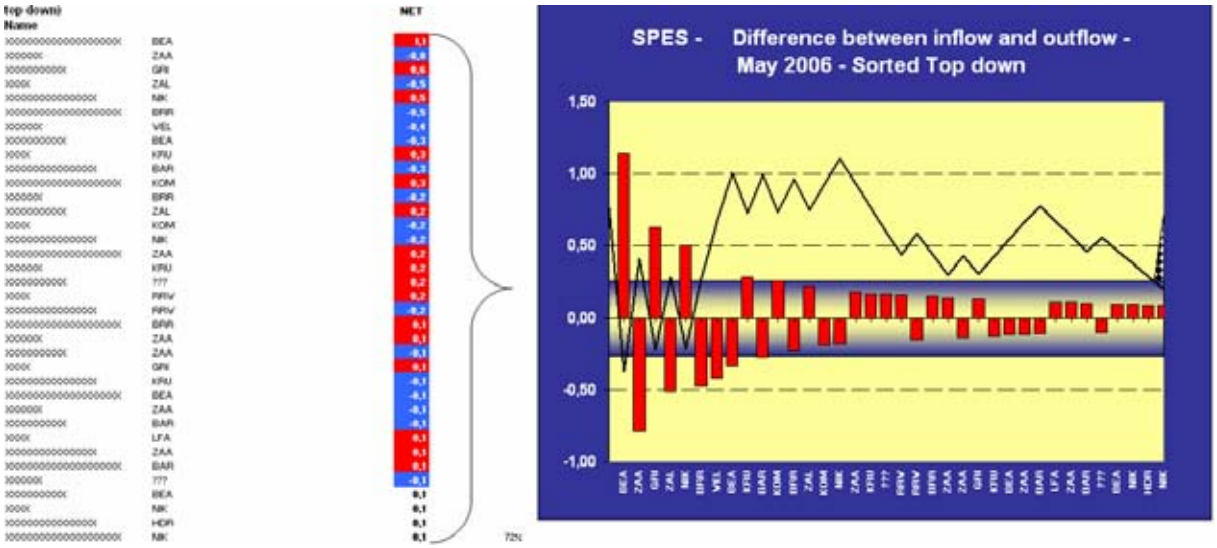
[21] The value of lambda can be chosen rather arbitrarily, depending on the preferred time perspective, even though in the literature a value of 100 is often recommended for annual data. See Bouthevillain et al (2000).

Annex 2
A tool to check net amounts reported by Dutch SPEs

Special purpose entities, or SPEs are an important category of reporters in the Netherlands, whose role is to pass through capital. Usually, the difference between inflows and outflows is not big, but if it is, action is taken to track the reporters that are responsible for it. The cause of the discrepancy usually is temporary, due to an item in transit, but the reporter may also have made an error or may not qualify anymore as an SPE. In the past, the reports of as many SPEs as possible were checked individually. This was time consuming, given the high number of SPEs (some 900), and because the two legs, inflows and outflows, were not always reported by one reporter but by several reporters all belonging to the same cluster of SPEs. To speed up the checking, a tool has been developed that drills down to individual clusters and SPEs (Figure 14).

Figure 14

Differences between the inflows and outflows reported by SPEs



The bars in the graph represent the net inflows, ranked top down, as reported by clusters of SPEs or by single SPE not belonging to a cluster.

The total net inflow of all reporters (the discrepancy) to be explained is the starting point of the line that goes from left to right.

The top down approach implies that priority is given to the highest net inflows first. As is clear from the example the one by one controling process can not be stopped, once the line has entered a margin of 0.25 billion euro, for instance. After the fifth bar/reporter, the line leaves the corridor again. In practice it usually takes about 30 to 40 bars before three quarters of the absolute net inflow is explained and the “finish” has been reached.

The table to the left of the graph shows the names of the reporters and the analysts that are supposed to take action (whose names are also on the horizontal axis of the graph).

Annex 3
A tool to detect amounts that look “too small”

The “small amount checker” is based on the assumption that if a reporter significantly contributes to an outlier, be it a small or a high amount, this should be reflected even more so in the individual time series reported by this reporter. Obviously, checking *all* individual reporters and *all* BOP items would go completely against the new top down philosophy. However, a quick inspection of suspicious *net amounts* of *all* transactions by reporter is straightforward and simple.

Figure 15 shows individual outliers in May 2006 for 30 reporters. The left hand graph shows for each reporter how much the net amount exceeds a historical, average net amount. The differences have been ranked top down. The net amounts reported over the past 32 months by an individual reporter (here the fourth from the top) are shown in the graph to the right. Zapping buttons facilitate the inspection of invidiual reporters in the top-30 and subsequent sets of reporters.

Obviously, the net amounts reported by individual reporters can not be interpreted as errors or omissions (E&Os). Nevertheless, when a reported net amount is significantly below or above its normal margin, this could point at errors or omissions at the company level contributing to errors and omissions at the aggregate level. The small amount checker therefore not only represents a one-figure-indicator of the quality of data reported by individual reporters but is also a useful tool in the analysis of E&Os.

Figure 15

Zapping through outliers in net amounts reported by individual reporters