DG ECFIN's validation strategy for Business and Consumer Surveys back-cast series

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Introduction

Le papier décrit la stratégie de la DG ECFIN pour valider les séries rétropolées envoyées par les instituts partenaires dans le cadre du programme européen harmonisé des enquêtes de conjoncture. Suite au changement de nomenclature NACE1 vers NACE2, la DG ECFIN a demandé à ses partenaires de fournir des séries rétropolées en NACE2. Ce travail a été inégalement effectué par les partenaires pour des raisons propres à chacun des instituts. De plus, pour de nombreux pays, les séries rétropolées en NACE2 avaient (sensiblement) moins de profondeur que les séries en NACE1.

Le but de la stratégie de validation était donc double : assurer la disponibilité de séries en NACE2 sans rupture de séries dues au changement de nomenclature et (surtout) obtenir des séries d'une profondeur maximale. En effet, la disponibilité de séries longues est une condition très importante pour les utilisateurs des enquêtes de conjoncture harmonisées.

La stratégie est basée sur une méthode économétrique originale (modélisation AR, tests Bai-Perron, reconstitution des séries de manière récursive). Elle a permis in fine de prolonger / rétropoler des données d'enquêtes (soldes d'opinion) suite au changement de nomenclature (NACE1 vers NACE2), pour certains pays qui n'avaient pas pu / su rétropoler leurs données avec suffisamment de profondeur demandées par la DG ECFIN.

1. Background

NACE is the statistical classification of economic activities in the European Union: it provides a reference framework for the production and the dissemination of statistics related to economic activities. Statistics produced on the basis of NACE are comparable at European level and, in general, at world level in line with the United Nations' International Standard Industrial Classification of all Economic Activities (ISIC).

Since May 2010, the Direction General for Economic and Financial Affairs (DG ECFIN) of the European Commission publishes its Business and Consumer Survey (BCS) results according to the NACE Revision 2 classification (NACE2). The changeover from the former nomenclature NACE 1.1 (NACE1), which was in use until April 2010, to the NACE2, aims at reflecting technological developments and changes of the economy. Indeed, since 2000, a major revision of international and European classifications of economic activities and products has taken place. In the case of the European Union, Regulation (EC) No 1893/2006 (hereinafter referred to as 'the Regulation') established NACE Revision 2 as the new basis for classifying economic activities. As stated in the same Regulation, an up-to-date classification such as NACE2 is central to the Commission's ongoing efforts to modernise the production of EU statistics. In 2009, Eurostat started publishing short-term and structural business statistics according to NACE2, while national accounts implemented the change in September 2011.

Responding to this development, BCS data - which are also part of the Principal European Economic Indicators - are now released according to NACE2: this makes the survey data even more comparable to short-term statistics and more fit as early indicators, prior to the actual publication of hard data, enabling thus better economic monitoring and decision making by governments, financial institutions, businesses and all other operators in the internal market.

The NACE2 changeover consists of a change in the identification and grouping of similar economic activities, which brings about a change in the way survey data are collected, grouped, and reported. The NACE2 classification has increased the level of detail, mainly in the services sector, so as to reflect the increased diversity and specificity of economic activities. This means that a number of activities, identified by numerical codes, are either completely new or have been distinguished from other activities and aggregated with more similar ones. As a consequence of the changes in the economy, some specific activities have been moved from a NACE1 section to a different NACE2 section; this is like in the case for 'publishing activities', which have been moved from manufacturing to the communication section, together with other services. The numerical codes in NACE2 may be different from those in NACE1, even though the composition of many groupings may remain broadly unchanged. Correspondence tables are used to map the old NACE1 codes into the new NACE2 codes.

Since the changeover to NACE2 entails a change in the identification and grouping of similar economic activities, this entails also a change in the sampling frame of enterprises and requires a modification of the samples currently used for collecting data, and therefore it involves *per se* a break in the survey time series. In order to have NACE2 survey series that are continuous (i.e. without spurious breaks due to nomenclature's change and as long as possible partner institutes participating in the Joint Harmonised Programme of Business and Consumer Surveys were invited to provide DG ECFIN with back-cast series back to 1985 for aggregate level (e.g. total industry, total services, …) in order to preserve as far as possible the original length and nature of the business survey series. Indeed, the length of available series is not only an important added value of the European Commission's business surveys, but this feature is also strongly required by DG ECFIN stakeholders and survey users.

2. The lack of a full backcast NACE2 dataset

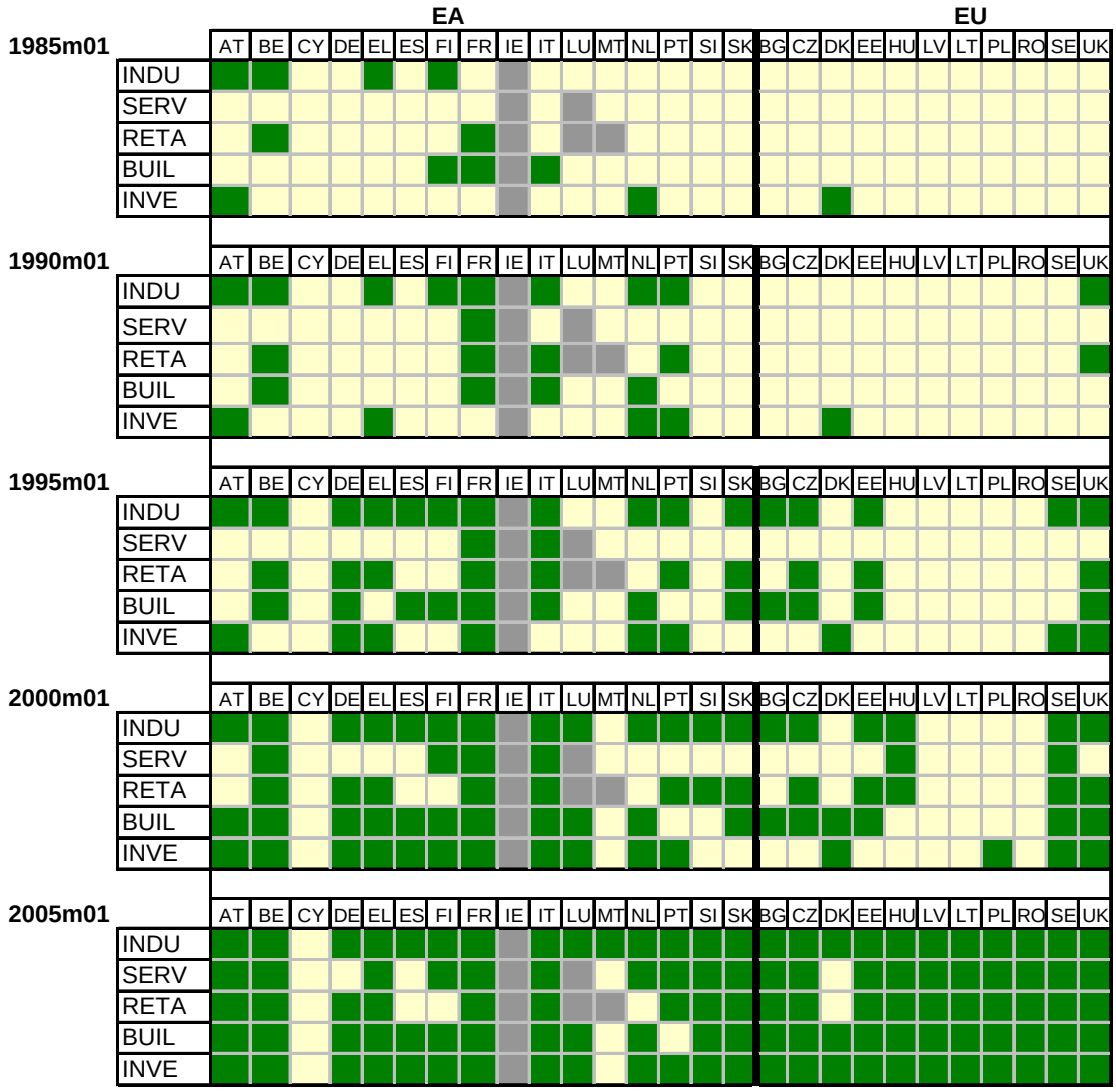
The backcasting exercise put in place by BCS partner institutes aimed at converting historic NACE1 data into new NACE2 format to produce continuous NACE2 series. However, BCS partner institutes experienced difficulties in yielding backcast series, which delayed the full availability of the NACE2 backcast dataset. In May 2010, only a maximum of 15 countries had provided backcast series (mainly in the industry sector): as the number of backcast series was insufficient to get an harmonised EU dataset, DG ECFIN decided to publish its survey time series

by splicing the former NACE1 series (for the data up to April 2010) with NACE2 series (data from May 2010 onwards).

Throughout the rest of 2010, BCS partner institutes continued to provide the backcast series, which were initially missing. Nevertheless, the appraisal done at the end of 2010 to take stock of the NACE2 backcast dataset was barely satisfactory. Actually, the number of missing backcast data was still significant when going back in the past (see Table 1). The sector with the higher number of backcast series was clearly industry, but only very few backcast series went back to 1985. Most of the provided backcast series were available from 2000, and even later for the other sectors.

The lack of a full backcast dataset raised an issue as it risked to prevent DG ECFIN from producing EU and Euro Area figures, which are among the main benefits and *raison d'être* of having an harmonised program of business surveys. To tackle this issue, DG ECFIN elaborated and put in place a validation strategy related to the NACE2 changeover. This validation process aimed i) at checking the quality of the back-cast series sent by the BCS partner institutes, ii) at making available continuous series and iii) at re-building as long as possible series, when the length of the backcast series was assessed as not satisfactory...

Table 1 - Picture of state of play in term of missing backast series



Note: this table gives a picture of the number of missing backast series (in yellow) per country and per survey at different points in time (Jan-2005, Jan-2000, Jan-1995, Jan-1990, Jan-1985).

3. The validation strategy – step by step

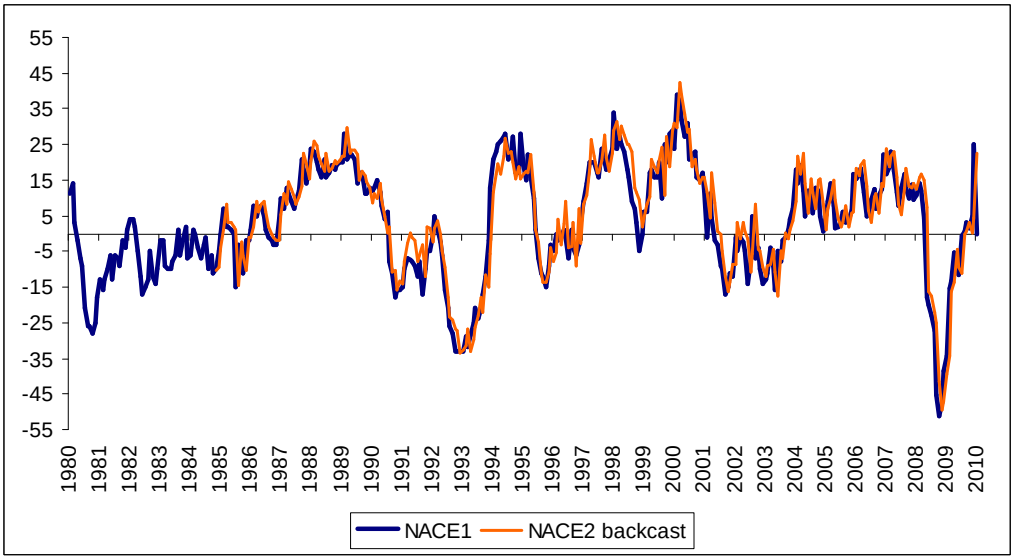
The overall purpose of the back-casting exercise was to re-constitute historical series according to the new (NACE2) classification, from the former existing series coded according to the old classification (NACE1). The number of series treated by DG ECFIN was roughly 1 000 (500 monthly and 500 quarterly time series), at aggregate level (e.g. total industry, total services, etc.).

In most cases, the NACE1 series were available with a longer time span than the NACE2 back-cast series received from BCS partner institutes (hereafter called "original NACE2 back-cast series"). Moreover, NACE1 data were collected and computed on real time, based on weighting schemes reflecting the share of the sub-sectors available at any given point in the past, while this was not replicable for NACE2 back-cast data, for which the sub-sector weights are not known in the past. Therefore, for the purpose of the validation, the NACE1 series were taken as the benchmark, in comparison to which the back-cast series were assessed, possibly re-calculated (even further back in the past) and then validated.

In this respect, each series was thought as of consisting of two segments (see Graph1):

- a historical time segment where only the NACE1.1 classification existed,
- an overlapping time segment where both NACE1.1 and the original NACE2 back-cast data were available (in a very few cases the overlapping time segment coincided with the whole length of the historical NACE1.1 series).

Graph 1 – NACE1 and NACE2 backcast series



For the purpose of the validation, the series (both NACE2 back-cast and NACE1) were examined in backward order (e.g. starting from April 2010 and going back in the past).

Step 1 – model the difference as an AR(p)

The difference d_t between the original NACE2 back-cast series and the old NACE1.1 series was modelled as a realisation of an autoregressive (AR) process on the overlapping period: $D_t \sim AR(p)$. The inspection of the empirical autocorrelation functions for a large sample of series confirmed that this is a reasonable assumption.

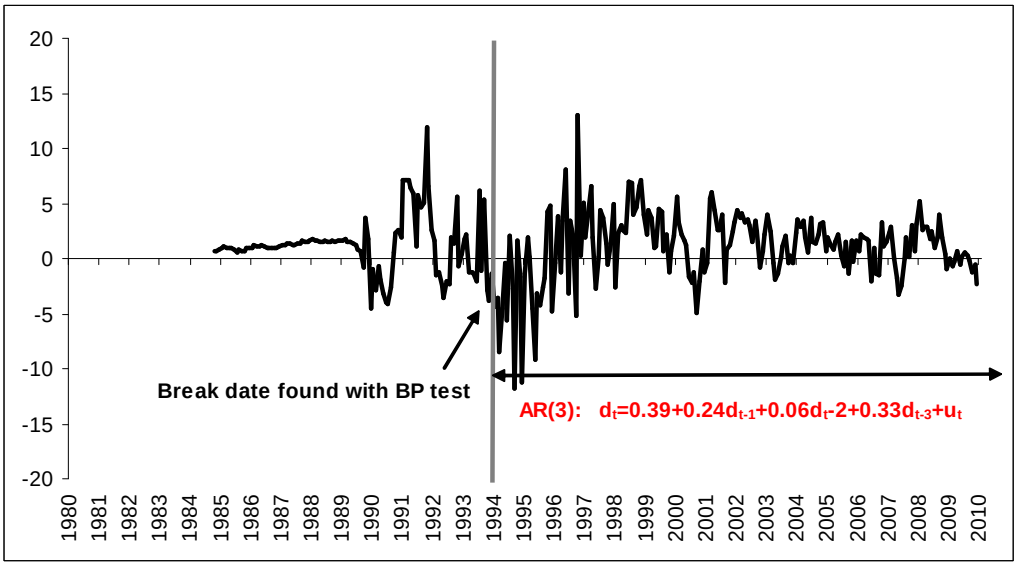
Within the class of AR models, the lag order p of the AR process was identified choosing the model for the series d_t which minimizes the Bayesian Information Criterion (BIC). The identification of p, specific to each series, was done through maximum likelihood estimation.

Step 2 – find a break

The possible presence of breaks in the difference series d_t was tested through the Bai-Perron (1998, 2003) procedure, which allows identifying the dates on which the breaks occur, too (see

Graph 2). This tool is widely used in the econometric and financial literature, as it relies on general enough assumptions and yields robust results.

Graph 2 – Break date found in the difference series



The Bai-Perron procedure makes use of a dynamic programming approach, by means of which structural changes in the mean (occurring at unknown dates) are detected. In a nutshell, the procedure aims at estimating the set of break-dates that split the series into homogeneous intervals, with different means. The estimation method is based on a least squares principle, so that the break-dates are those that minimize the residual sum of squares over all the possible partitions (see Box 1).

One of the main features of the Bai-Perron procedure is the ability to deal with and detect multiple breaks simultaneously. For the purpose of validating the NACE2 backcast series, the first break (going back to the past) was selected. However, any break occurring after January 2008 was discarded, in order to avoid identifying spurious breaks over the last 3 years, due to the higher volatility of the series during the crisis.

Step 3 – validate the NACE2 series from the break date

The break date, found for each time series, was used to split the original NACE2 backcast series in two sub-series, before and after the break. The back-cast data for the sub-period from the break date up to April 2010 were therefore considered as validated, whereas those for the sub-period from the beginning of the back-cast series up to the break date were not.

Step 4 – rebuild and prolong NACE2 series before the break date

The AR(p) model, which had been identified in Step 1, was re-estimated on the validated sub-period. The estimated AR coefficients were then used to convert the NACE1 series into a NACE2 series -for the sub-period before the break date.

As $d_t = b_0 + \Sigma_{j=1,\ ...,\ p}\, b_j(d_{t-j})$, this was done recursively through the following relationship:

$NACE2_t = NACE1_t + b_0 + \Sigma_{j=1,\ ...,\ p}\, b_j(d_{t-j})$,

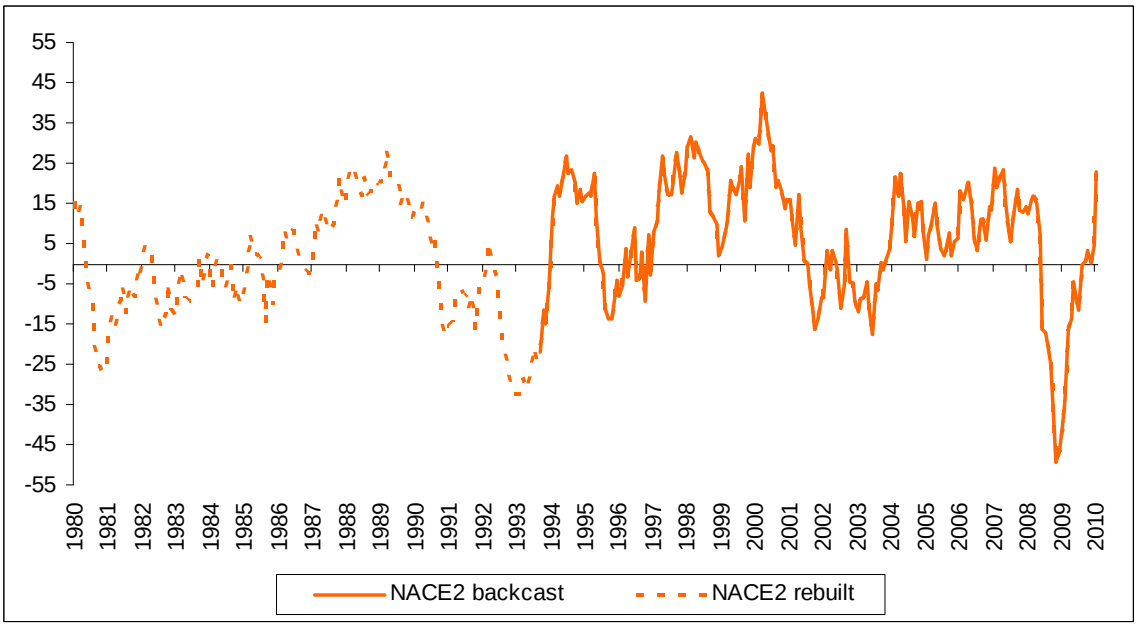
where b_0 and bj (j = 1, …, p) are the estimated AR(p) coefficients and d_{t-j} is the difference between the NACE2 back-cast series and the NACE1.1 series at time (t-j).

The logic behind this step rested in replicating the same autoregressive structure, which had been estimated on the validated back-cast series, in the sub-period before the break date. This was achieved by applying the estimated autoregressive coefficients to the series NACE1 taken as benchmark through the whole validation process. This allowed smoothing the transition between the two series (see Graph 3). Furthermore, the adopted approach allowed to have NACE2 series

as long as the original NACE1 series, even when the available back-cast series was shorter, which was very often the case.

Final series were then sent to BCS partners institutes for reaction and approval.

Graph 3 – NACE2 series extended further in the past



Box 1 : Bai – Perron Test

Considering the standard linear regression model,

$$y_i = x_i'b_i + u_i \quad (i = 1,..., t)$$

where at time i, y_i is the observation of the dependent variable, x_i is a $k \times 1$ vector of regressors, and b_i is the $k \times 1$ vector of regression coefficients, which may vary over time, the basic idea of the Bai-Perron (2003) relies on testing the hypothesis that the regression coefficients remain constant:

$$H_0 : b_i = b_0 \quad (i = 1,..., t)$$

against the alternative that at least one coefficient varies over time. In many applications it is reasonable to assume that there are m breakpoints, where the coefficients shift from one stable regression relationship to a different one.

Thus, there are $m+1$ segments in which the regression coefficients are constant, and the general regression model can be rewritten as

$$y_i = x_i'b_i + u_i \quad (i = i_{j-1} + 1, \ldots, i_j; \; j = 1, \ldots, m+1),$$

where j is the segment index, $i_{m,t} = \{i_1,..., i_m\}$ denotes the set of the breakpoints (called also called m-partition), and by convention $i_0 = 0$ and $i_{m+1} = t$. In practice however, the breakpoints are rarely given exogenously but are unknown and have to be estimated from the data.

Given an m-partition $i_1,...,i_m$ the least squares estimates for the b_i can easily be obtained. The resulting minimal residual sum of squares is given by

$$RSS(i_1,...,i_m) = \sum_{j=1}^{m+1} rss(i_{j-1} + 1, i_j),$$

where $rss(i_{j-1} + 1, \ldots, i_j)$ is the usual minimal residual sum of squares in the jth segment. The problem of dating structural changes is to find the breakpoints $i^*_1,...,i^*_m$ that minimize the objective function over all partitions $(i_1,...,i_m)$:

$$(i^*_1,...,i^*_m) = \arg\min_{(i_1,...,i_m)} RSS(i_1,...,i_m)$$

Obtaining the global minimisers in this expression by an extensive grid search would be computationally burdensome for $m > 2$ (and any reasonable sample size t). Therefore, many hierarchical algorithms have been proposed to do recursive portioning or joining subsamples, but this will not necessarily find the global minimisers. These can be found much easier by dynamic programming approach for any number of changes m. Bai and Perron (2003) present a version of that dynamic programming algorithm for pure and partial structural change models in an OLS regression context. The idea is that of Bellman's principle: the optimal segmentation satisfies the recursion

$$RSS(I_{m,n}) = \min_i [RSS(I_{m-1}, i) + rss(i+1, t)].$$

Therefore it suffices to know for each point i the "optimal previous partner" if i was the last breakpoint in an m-partition. This can be derived from a triangular matrix of $rss(i,j)$, the computation of which is again made easier by the recursive relation $rss(i,j) = rss(i,j\text{-}1) + r(i,j)^2$, where $r(i,j)$ is the recursive residual at time j of a sample starting at i.

Conclusion

To allow an effective changeover to NACE2, DG ECFIN elaborated and put in place a validation strategy which had the objective to make available to final users validated series that are both continuous and as long as possible.

As a result of the validation process, DG ECFIN published in February 2011 a NACE2 validated database with back-cast series at aggregate level (e.g. total industry, total services, etc.) on the basis of a model-based methodology presented in this paper.

This database contains DG NACE2 BCS series, obtained by splicing:

- the NACE2 series re-built according to the 4 steps described in section 3 (for the sub-period before the break date)

- the NACE2 back-cast series as provided by the BCS partner (for the sub-period after the break date until April 2010)

- the NACE2 series as provided by the BCS partner from May 2010 onwards.

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